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A REPORT ON

A COOPERATIVE BACTERIOLOGICAL STUDY OF WATERS FROM LAKE MICHIGAN IN THE VICINITY OF DUNBE CRIB AND OF TREATED WATERS OF THE SOUTH CHICAGO WATER SUPPLY.

By

C. T. Butterfield, Principal Bacteriologist, and
Elsie Wattie, Associate Bacteriologist

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U. S. Public Health Service
Stream Pollution Investigations
Cincinnati, Ohio

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1942

A REPORT ON A COOPERATIVE BACTERIOLOGICAL STUDY* OF WATERS FROM LAKE MICHIGAN IN THE VICINITY OF DUNNE CRIB AND OF TREATED WATERS OF THE SOUTH CHICAGO WATER SUPPLY.

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INTRODUCTION

Reference is made to "A Report on Pollution of Lake Michigan in the Vicinity of Chicago's Southerly Water Intakes". This report was prepared by Senior Sanitary Engineer L. H. Fisher, upon instructions from the Chief Engineer of the Sanitation Section, U. S. Public Health Service. Necessarily the factual data used by Mr. Fisher in the preparation of his report were obtained largely by the City of Chicago in their laboratories and from other available records. It was felt by the Surgeon General of the U. S. Public Health Service and by the President of the Board of Health of the City of Chicago that the Public Health Service should obtain factual data of its own and should assure itself that the data being collected by the City of Chicago were accurate and reliable. Accordingly, instructions were issued by the Chief, Sanitation Section, U. S. Public Health Service, to make the necessary arrangements and to carry on the necessary studies to obtain the required information in cooperation with the District Director, U. S. Public Health Service District No. 3.

(*) This study was carried on as a cooperative activity with U. S. Public Health Service District No. 3, Chicago, Ill.

pose of the study, (2) the cooperative agreements, (3) the samples to be collected and examined, (4) the methods to be followed in collection and examination, and (5) the reporting of results. It is attached hereto as Appendix I of this report.

Two procedures are provided for in this agreement, one hereinafter referred to as the Standardized Procedures, and one referred to as the Chicago Board of Health Routine Procedure. As this protocol presents in detail the procedures followed and the conditions governing the study no further consideration will be given to such matters here.

Scope of the Study

Full scale observations at all of the participating laboratories were instituted on March 18, 1942, and were continued through to August 28, 1942. These observations were arranged to yield information concerning the following points:

(1) The bacterial quality of the raw waters, particularly at the Dunne Crib intake, as determined by each of the three laboratories using the standardized procedure.

(2) A comparison of the bacterial results obtained by the Chicago Board of Health laboratory using their routine procedure and the standardized procedure on the same samples.

(3) A comparison of the results obtained from samples delivered soon after collection by the Public Health Service carrier with results obtained from aliquot portions

Preliminary Arrangements

To initiate this study, a conference was held on February 27, 1942, in the office of the President of the Board of Health of Chicago. This conference was attended by Dr. Bundesen, Mr. Connolly and Dr. White of the Chicago Health Department, by Dr. Day of the Department of Bacteriology of Northwestern University Medical School, and by Mr. Fisher and Mr. Butterfield of the U.S. Public Health Service. Dr. Day of Northwestern University was invited to the conference at the request of Dr. Bundesen for probable participation as an independent investigator in the studies which might be undertaken.

At this conference arrangements were completed for a cooperative study to be undertaken by the parties designated, namely, (1) the City of Chicago through its Health Department and its Department of Public Works, (2) the Department of Bacteriology of Northwestern University, and (3) the U. S. Public Health Service. The Public Health Service agreed (1) to supervise the study, (2) to obtain a complete set of data of their own, and (3) to draw up detailed instructions to govern the entire study.

As a preliminary step to the preparation of these instructions, previous results were studied and a careful survey was made of the water laboratory of the Chicago Health Department. A detailed protocol was prepared and agreed to by all agencies concerned. This protocol set forth among other things: (1) the pur-

of the same samples held at the point of collection for delivery to the Chicago Board of Health laboratory by the routine Board of Health carrier. ("Crib held" samples).

(4) Observations on the effect of treatment of raw Lake Michigan water (Dunne Crib samples) with a dechlorinating agent, thiosulphate, when examined by:

(a) The Public Health Service, using the standardized procedure

(b) Northwestern University, using the standardized procedure

(c) Chicago Board of Health, using the standardized procedure

(d) Chicago Board of Health, using their routine procedure

(e) All three laboratories using the standardized procedure, when average results were considered.

(5) The influence of direct planting in the field at the time of collection on coliform results obtained, compared with results from aliquot portions of the same sample transported to the laboratory for examination with and without the addition of a dechlorinating agent at the time of collection.

(6) Observations on the course of travel of pollution from south of Dunne Crib as measured by a limited number of lake survey samples.

(7) Observations on the number of times the coliform content

of Dunne Crib water equalled or exceeded an M.P.N. of 50 per 100 ml. of sample during the course of the study.

In obtaining this information, 484 routine samples were subjected to approximately 8000 bacteriological examinations and 48 lake survey samples were studied. In addition, the Chicago Board of Health collected, with their own collector at the same time that the Public Health Service master sample was collected, 342 samples for examination by their routine procedure. These results were available for comparative study.

Results

In making a critical study of the results obtained, 48 tables of data covering the individual items of each examination have been used. These data are presented here in the form of weekly averages for Dunne Crib intake samples, Table 1A, Plate counts per ml., and Table 1B, Coliforms, M.P.N. per 100 ml., and in the form of monthly averages for Dunne Crib* intake, Control Booth*, Pumping Station* and Distribution System* samples, Table 2A, Plate Counts per ml., and Table 2B, Coliforms, M.P.N. per 100 ml. (The detailed tables of tabulated results from individual

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(*) The source of these samples may be described as follows: (1) Dunne Crib, raw Lake Michigan water collected at Dunne Crib intake which is approximately four miles straight out in the lake from 68th St. Pumping Station; (2) Control Booth, water from Lake Michigan at Dunne Crib, treated with chlorine or chloramine at the Crib, after flowing four miles to the 68th St. Pumping Station; (3) Pumping Station, water from Lake Michigan at Dunne Crib collected immediately after receiving a second treatment with chlorine or chloramine at the Control Booth; (4) Distribution System, water as delivered from 68th St. Pumping Station collected at various points in the distribution system.

samples are available for study if desired. They have been used as source material for the data presented in Table 4, etc., in the "Analysis of Results" below.

(Insert Tables 1A, 1B, 2A and 2B)

The results obtained in the lake survey series of the study, covering to a limited extent that section of the lake between Dunne Crib and Indiana Harbor, are presented in Tables 3A to 3H inclusive. As the number of samples examined in the lake survey series was not large, the results from individual samples are given in the tables. Single samples from two additional sampling points in the lake, points 13 and 23 as shown in Charts VI-A and VI-B were examined during the survey. The results from these samples collected on August 27, 1942, in the arrangement given in the tables (namely Public Health Service, Northwestern, Board of Health and Board of Health routine) were for sample point 13, Coliforms, M.P.N. per 100 ml., 33,000, 17,000, 35,000 and 9,500; Plate count per ml. 2750, 6050, 14,800 and 9,400; and for sample point 23, Coliforms, M.P.N. per 100 ml., 2400, 160,000, 3500 and 30,000; Plate count per ml., 17,100, 24,000, 2600 and 490, respectively.

(Insert Tables 3A, 3B, 3C, 3D, 3E, 3F, 3G and 3H)

Analysis of Results

1. Observations on the bacterial quality of Dunne Crib intake water as determined by each of the three cooperating laboratories using the standardized procedure. This also provided an

TABLE 1A

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water

verages, March 18 to August 28, 1942. Dunne Crib Samples, Plate Count per ml.

Master Sample Collected by U.S.P.H.S.										Temp. °F.
Delivered to Laboratories by U.S.P.H.S. Carrier								Delivered to B. of H. Lab. by B. of H. Carrier	Sample Collected by City at same time as Master Sample. Delivered to B. of H. Lab. in Routine Way.	
Sample Not Dechlorinated				Sample Dechlorinated						
U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	Not Dechlorinated B. of H.	Not Dechlorinated B. of H.	
1	7	6	8	1	8	10	5		775	35
158	198	186	184	182	206	289	244		1010	37
45	90	196	102	57	87	137	84		150	38
7	54	34	29	5	119	35	24		5	40
34	48	60	25	49	51	51	40		64	41
4	12	22	7	4	12	36	10		12	47
846	1200	1050	628	1160	1560	1470	1210	670	511	47
201	427	1360	130	203	571	403	162	115	234	49
84	303	86	42	227	435	188	90	76	95	51
102	64	31	10	96	64	40	13	2330	7130	53
74	41	25	21	92	67	5	24	17	31	54
140	34	38	34	151	26	48	33	13	15	59
8	22	7	4	11	30	18	13	2	2	62
4	23	17	7	9	31	28	17	3	4	62
16	35	14	29	70	49	44	59	87	10	63
36	15	49	36	86	47	54	39	136	73	63
21	11	18	3	36	28	21	20	96	569	66
289	222	124	109	350	263	178	141	67	67	64
9	24	3	3	15	44	4	63	3	10	68
8	33	2	2	32	22	22	13	18000	6	70
221	182	112	45	286	233	158	52	104	32	69
6	31	9	12	49	79	76	59	5	19	70
27	146	4	4	49	272	32	14	16	4	71
499	715	186	131	780	795	242	201	761	528	67

TABLE 1A

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water

Weekly Averages, March 18 to August 28, 1942. Dunne Crib Samples, Plate Count per ml.

Week Ending 1942		Master Sample Collected by U.S.P.H.S.									Sample Collected City at same Master Sample livered to B. Lab. in Routi
		Delivered to Laboratories by U.S.P.H.S. Carrier								Delivered to B. of H. Lab. by B. of H. Carrier	
		Sample Not Dechlorinated				Sample Dechlorinated				Not Dechlorinated	Not Dechlori
		U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	B. of H.	B. of H.
March	20	1	7	6	8	1	8	10	5		775
	27	158	198	186	184	182	206	289	244		1010
April	3	45	90	196	102	57	87	137	84		150
	10	7	54	34	29	5	119	35	24		5
	17	34	48	60	25	49	51	51	40		64
	24	4	12	22	7	4	12	36	10		12
May	1	846	1200	1050	628	1160	1560	1470	1210	670	511
	8	201	427	1360	130	203	571	403	162	115	234
	15	84	303	86	42	227	435	188	90	76	95
	22	102	64	31	10	96	64	40	13	2330	7130
	29	74	41	25	21	92	67	5	24	17	31
June	5	140	34	38	34	151	26	48	33	13	15
	12	8	22	7	4	11	30	18	13	2	2
	19	4	23	17	7	9	31	28	17	3	4
	26	16	35	14	29	70	49	44	59	87	10
July	3	36	15	49	36	86	47	54	39	136	73
	10	21	11	18	3	36	28	21	20	96	569
	17	289	222	124	109	350	263	178	141	67	67
	24	9	24	3	3	15	44	4	63	3	10
	31	8	33	2	2	32	22	22	13	18000	6
August	7	221	182	112	45	286	233	158	52	104	32
	14	6	31	9	12	49	79	76	59	5	19
	21	27	146	4	4	49	272	32	14	16	4
	28	499	715	186	131	780	795	242	201	761	528

TABLE 1B

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water

ekly Averages, March 18 to August 28, 1942. Dunne Crib Samples, Coliforms, M.P.N. per 100 ml.

ek ding 42		Master Sample Collected by U.S.P.H.S.								Sample Collected by City at same time as Master Sample. Delivered to B. of H. Lab. in Routine Way.	Temp.
		Delivered to Laboratories by U.S.P.H.S. Carrier.							Delivered to B. of H. Lab. by B. of H. Carrier.		
		Sample Not Dechlorinated				Sample Dechlorinated					
		U.S.P.H.S.	N.W.	B. of H.	B. of H Routine	U.S.P.H.S.	N.W.	B. of H.	B. of H Routine	Not Dechlorinated B. of H.	Not Dechlorinated B. of H.	•F.
ch	20	2.2	2.2	1.8	0.0	1.3	1.3	0.0	0.0	—	0.0	35
	27	27.3	36.7	10.5	28.2	14.4	31.0	28.9	10.0	24.0	10.2	37
il	3	14.0	7.4	13.4	51.6	17.9	12.6	13.1	11.6	51.8	8.0	38
	10	2.2	1.2	2.3	1.8	2.7	1.7	5.4	5.2	2.6	3.2	40
	17	108.0	38.3	116.0	58.0	73.1	31.0	100.0	57.6	59.6	11.0	41
	24	1.7	2.0	1.9	2.2	4.7	0.9	3.0	3.8	0.8	9.4	47
	1	55.6	51.8	30.2	155.0	126.0	101.0	63.0	73.2	153.0	21.2	47
	8	5.1	2.6	8.1	11.8	4.7	6.8	10.6	11.0	3.8	4.2	49
	15	200.0	175.0	89.6	64.0	198.0	136.0	53.6	606.0	12.2	60.5	51
	22	53.4	19.1	16.4	28.8	45.7	42.7	20.6	58.6	19.0	10.2	53
	29	209.0	64.8	59.0	67.2	210.0	27.8	58.7	7500.0	61.5	601.0	54
e	5	25.9	20.9	88.8	77.0	50.5	28.4	65.8	84.2	24.0	536.0	59
	12	72.4	36.3	43.8	73.8	79.7	41.2	83.0	588.0	69.2	500.0	62
	19	51.2	27.2	19.9	33.4	38.2	25.2	25.5	69.4	22.2	27.6	62
	26	370.0	214.0	258.0	545.0	507.0	351.0	367.0	104.0	533.0	498.0	63
y	3	70.9	28.2	21.5	63.8	49.4	17.5	43.2	532.0	60.8	22.4	63
	10	17.4	5.1	8.3	19.6	25.0	9.3	7.2	20.4	6.8	569.0	66
	17	1440.0	1110.0	1590.0	1260.0	1410.0	1840.0	1160.0	723.0	730.0	83.5	64
	24	52.5	25.7	12.9	14.8	59.1	25.1	27.7	63.4	16.8	10.0	68
	31	15.1	8.2	12.1	15.0	20.4	27.0	33.0	25.0	65.4	5.5	70
ust	7	1040.0	465.0	865.0	1320.0	670.0	852.0	1520.0	8200.0	1860.0	32.5	69
	14	160.0	93.0	90.8	623.0	120.0	140.0	122.0	1213.0	542.0	18.7	70
	21	162.0	200.0	134.0	130.0	310.0	160.0	144.0	2400.0	240.0	4.0	71
	28	628.0	1210.0	1500.0	679.0	715.0	2320.0	1020.0	1270.0	584.0	528.0	67

TABLE 1B

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water

Weekly Averages, March 18 to August 28, 1942. Dunne Crib Samples, Coliforms, M.P.N. per 100 ml.

Week Ending 1942		Master Sample Collected by U.S.P.H.S.								Sample Coll City at sa Master Sam livered to Lab. in Ro
		Delivered to Laboratories by U.S.P.H.S. Carrier.								Delivered to B. of H. Lab. by B. of H. Carrier.	
		Sample Not Dechlorinated				Sample Dechlorinated				Not Dechlorinated	Not Dechl
		U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	B. of H.	B. of
March	20	2.2	2.2	1.8	0.0	1.3	1.3	0.0	0.0	—	0.0
	27	27.3	36.7	10.5	28.2	14.4	31.0	28.9	10.0	24.0	10.2
April	3	14.0	7.4	13.4	51.6	17.9	12.6	13.1	11.6	51.8	8.0
	10	2.2	1.2	2.3	1.8	2.7	1.7	5.4	5.2	2.6	3.2
	17	108.0	38.3	116.0	58.0	73.1	31.0	100.0	57.6	59.6	11.0
	24	1.7	2.0	1.9	2.2	4.7	0.9	3.0	3.8	0.8	9.4
May	1	55.6	51.8	30.2	155.0	126.0	101.0	63.0	73.2	153.0	21.2
	8	5.1	2.6	8.1	11.8	4.7	6.8	10.6	11.0	3.8	4.2
	15	200.0	175.0	89.6	64.0	138.0	136.0	53.6	606.0	12.2	60.5
	22	53.4	19.1	16.4	28.8	45.7	42.7	20.6	58.6	19.0	10.2
	29	209.0	64.8	59.0	67.2	210.0	27.8	58.7	7500.0	61.5	601.0
June	5	25.9	20.9	88.8	77.0	50.5	28.4	65.8	84.2	24.0	536.0
	12	72.4	36.3	43.8	73.8	79.7	41.2	83.0	588.0	69.2	500.0
	19	51.2	27.2	19.9	33.4	38.2	25.2	25.5	69.4	22.2	27.6
	26	370.0	214.0	258.0	545.0	507.0	351.0	367.0	104.0	533.0	498.0
July	3	70.9	28.2	21.5	63.8	49.4	17.5	43.2	532.0	60.8	22.4
	10	17.4	5.1	8.3	19.6	25.0	9.3	7.2	20.4	6.8	569.0
	17	1440.0	1110.0	1590.0	1260.0	1410.0	1840.0	1160.0	723.0	730.0	83.5
	24	52.5	25.7	12.9	14.8	59.1	25.1	27.7	63.4	16.8	10.0
	31	15.1	8.2	12.1	15.0	20.4	27.0	33.0	25.0	65.4	5.5
August	7	1040.0	465.0	865.0	1320.0	670.0	852.0	1520.0	8200.0	1860.0	32.5
	14	160.0	93.0	90.8	623.0	120.0	140.0	122.0	1213.0	542.0	18.7
	21	162.0	200.0	134.0	130.0	310.0	160.0	144.0	2400.0	240.0	4.0
	28	628.0	1210.0	1500.0	679.0	715.0	2320.0	1020.0	1270.0	584.0	528.0

TABLE 2A

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water and of Treated Waters of the South Chicago Water Supply.

to August 28, 1942	Plate Count per ml.										
	Master Sample Collected by U.S.P.H.S.									Sample Collected by City at same time as Master Sample. Delivered to B. of H. Lab. in Routine Way.	
Cl_2 at Sampling	Delivered to Laboratories by U.S.P.H.S. Carrier.								Delivered to B. of H. Lab. by B. of H. Carrier.		Temp.
	Sample Not Dechlorinated				Sample Dechlorinated						
p.p.m.	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	U.S.P.H.S.	N.Y.	B. of H.	B. of H. Routine	Not Dechlorinated B. of H.	Not Dechlorinated B. of H.	°F.
0.0	96	138	206	145	116	140	232	163	-	861	36.6
0.0	195	248	241	144	265	330	324	261	169	119	43.0
0.0	120	256	403	63	161	342	204	104	620	1810	51.8
0.0	40	28	20	19	68	37	36	33	27	21	61.5
0.0	67	58	32	28	91	76	51	39	4350	151	66.5
0.0	211	286	88	54	325	355	140	87	252	170	69.4
0.44	2	8	2	3	1	9	2	3			40.6
0.34	4	3	4	2	4	3	5	1			45.8
0.37	2	5	6	1	1	7	7	1			54.1
0.36	1	3	1	1	1	3	2	1			62.0
0.34	1	1	1	1	1	2	1	1			67.0
0.34	1	1	1	1	1	1	1	1			69.6
0.61	2	5	2	3	2	10	2	4			41.1
0.59	2	3	5	1	2	3	3	2			43.8
0.60	1	3	6	1	2	5	7	1			53.5
0.56	1	2	1	1	1	3	2	1			62.5
0.56	1	1	1	1	1	1	1	1			66.9
0.59	1	1	1	1	1	1	1	1			69.5
0.25	2	8	2	2	2	10	2	3			
0.24	3	8	5	2	3	5	2	3			
0.34	1	4	5	2	1	5	6	1			
0.11	1	3	6	1	1	9	5	2			
0.096	1	2	3	6	1	2	2	4			
0.15	1	1	1	1	2	4	2	2			

TABLE 2A

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water and of Treated Waters of the South Chicago Water Supply.

Monthly Averages, March 18 to August 28, 1942 — Plate Count per ml.

Master Sample Collected by U.S.P.H.S.

Sampling Point	Month 1942	Residual Cl_2 at Time of Sampling		Delivered to Laboratories by U.S.P.H.S. Carrier.								Delivered to B. of Lab. by B. of H. Carrier.
				Sample Not Dechlorinated				Sample Dechlorinated				
		Lbs. per M.G.	p.p.m.	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	U.S.P.H.S.	N.W.	B. of H.	B. of H. Routine	Not Dechlorinated B. of H.
Dunne Crib	March	0.0	0.0	96	138	206	145	116	140	232	163	-
	April	0.0	0.0	195	248	241	144	265	330	324	261	169
	May	0.0	0.0	120	256	409	63	161	342	204	104	620
	June	0.0	0.0	40	28	20	19	68	37	36	33	27
	July	0.0	0.0	67	58	32	28	91	76	51	39	4350
	August	0.0	0.0	211	286	88	54	325	355	140	87	252
Control Booth	March	3.6	0.44	2	8	2	3	1	9	2	3	
	April	2.8	0.34	4	3	4	2	4	3	5	1	
	May	3.1	0.37	2	5	6	1	1	7	7	1	
	June	3.0	0.36	1	3	1	1	1	3	2	1	
	July	2.8	0.34	1	1	1	1	1	2	1	1	
	August	2.8	0.34	1	1	1	1	1	1	1	1	
Pumping Station	March	5.0	0.61	2	5	2	3	2	10	2	4	
	April	4.9	0.59	2	3	5	1	2	3	3	2	
	May	5.0	0.60	1	3	6	1	2	5	7	1	
	June	4.7	0.56	1	2	1	1	1	3	2	1	
	July	4.7	0.56	1	1	1	1	1	1	1	1	
	August	4.9	0.59	1	1	1	1	1	1	1	1	
Distribution System	March	2.1	0.25	2	8	2	2	2	10	2	3	
	April	2.0	0.24	3	8	5	2	3	5	2	3	
	May	2.8	0.34	1	4	5	2	1	5	6	1	
	June	0.92	0.11	1	3	6	1	1	9	5	2	
	July	0.81	0.096	1	2	3	6	1	2	2	4	
	August	1.3	0.15	1	1	1	1	2	4	2	2	

TABLE 2B

ive Study of the Bacterial Quality of Raw Lake Michigan Water and of Treated Waters of the South Chicago Water Supply.

18 to August 28, 1942. Coliforms, M.P.N. per 100 ml.

al Cl2 at f Sampling		Master Sample Collected by U.S.P.H.S. Delivered to Laboratories by U.S.P.H.S. Carrier. Sample Not Dechlorinated				Sample Dechlorinated				Delivered to B. of H. Lab. by B. of H. Carrier.		Sample Collected by City at same time as Master Sample. Delivered to B. of H. Lab. in Routine Wax.		Temp.
G.	p.p.m.	U.S.P.H.S.	N.W.	B of H	B. of H. Routine	U.S.P.H.S.	N.W.	B of H	B. of H Routine	Not Dechlor. B. of H.	Dechlor. B. of H.	Not Dechlor. B. of H.	Dechlor. B. of H.	°F.
	0.0	16.4	20.4	8.8	15.5	11.0	17.1	15.9	6.8	15.5		7.7		36.6
	0.0	39.8	21.9	53.2	58.6	45.9	31.4	38.1	31.9	42.8		10.5		43.0
	0.0	107.0	59.6	40.1	41.4	109.0	51.5	36.9	1820.0	36.8		144.0		51.8
	0.0	139.0	76.5	97.8	183.0	172.0	108.0	134.0	323.0	165.0		260.0		61.6
	0.0	298.0	220.0	311.0	253.0	296.0	365.0	238.0	164.0	163.0		167.0		66.5
	0.0	560.0	534.0	722.0	768.0	474.0	970.0	738.0	3400.0	818.0		235.0		69.4
	0.44	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.0	---	---	0.0	0.0	40.6
	0.34	0.0	0.08	0.09	0.0	0.19	0.09	0.08	0.0	0.0	0.0	0.0	0.0	45.8
	0.37	0.09	0.0	0.09	0.0	0.09	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54.1
	0.36	0.09	0.0	0.0	0.0	0.45	0.09	0.09	0.18	0.0	0.18	0.0	0.32	62.0
	0.34	0.0	0.0	0.0	0.33	0.28	0.48	0.47	0.0	0.0	0.10	---	---	67.0
	0.34	0.0	0.0	0.0	0.0	0.14	0.14	0.14	0.14	0.0	0.0	---	---	69.6
	0.61	0.0	0.20	0.0	0.0	0.40	0.60	0.0	0.0					41.1
	0.59	0.09	0.0	0.09	0.0	0.0	0.0	0.0	0.0					43.8
	0.60	0.0	0.0	0.0	0.0	0.09	0.0	0.0	0.52					53.5
	0.56	0.18	0.09	0.0	0.0	0.0	0.0	0.09	0.23					62.5
	0.56	0.0	0.0	0.0	0.0	0.0	0.09	0.0	0.0					66.9
	0.59	0.14	0.0	0.0	0.0	0.28	0.0	0.0	0.0					69.5
	0.25	0.20	0.20	0.20	0.0	0.20	0.0	0.0	0.0					
	0.24	0.09	0.0	0.09	0.0	0.0	0.09	0.0	0.0					
	0.34	0.0	0.0	0.37	0.43	0.00	0.09	0.09	0.0					
2	0.11	0.0	0.0	0.0	0.09	0.45	0.0	0.30	0.0					
1	0.096	0.19	0.0	1.0	1.8	0.09	0.0	0.21	0.09					
	0.15	0.88	0.0	0.0	0.0	0.6	0.0	0.32	0.57					

TABLE 2B

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water and of Treated Waters of the South Chi

Monthly Averages, March 18 to August 28, 1942. Coliforms, M.P.N. per 100 ml.

Master Sample Collected by U.S.P.H.S.

Sampling Point	Month 1942	Residual Cl_2 at Time of Sampling		Delivered to Laboratories by U.S.P.H.S. Carrier.								Delivered to B. of H. Lab. by B. of H. Carrier.	
				Sample Not Dechlorinated				Sample Dechlorinated					
		Lbs. per M.G.	p.p.m.	U.S.P.H.S.	N.W.	B of H	B. of H. Routine	U.S.P.H.S.	N.W.	B of H	B. of H Routine	Not Dechlor. B. of H.	Dechlor. B. of H.
Dunne Crib	March	0.0	0.0	16.4	20.4	8.8	15.5	11.0	17.1	15.9	6.8	15.5	
	April	0.0	0.0	39.8	21.9	53.2	58.6	45.9	31.4	38.1	31.9	42.8	
	May	0.0	0.0	107.0	59.6	40.1	41.4	109.0	51.5	36.9	1820.0	36.8	
	June	0.0	0.0	139.0	76.5	97.8	183.0	172.0	108.0	134.0	323.0	165.0	
	July	0.0	0.0	298.0	220.0	311.0	253.0	296.0	365.0	238.0	164.0	163.0	
	August	0.0	0.0	560.0	534.0	722.0	768.0	474.0	970.0	738.0	3400.0	818.0	
Control Booth	March	3.6	0.44	0.2	0.2	0.0	0.0	0.0	0.2	0.0	0.0	---	---
	April	2.8	0.34	0.0	0.08	0.09	0.0	0.19	0.09	0.08	0.0	0.0	0.0
	May	3.1	0.37	0.09	0.0	0.09	0.0	0.09	0.0	0.0	0.0	0.0	0.0
	June	3.0	0.36	0.09	0.0	0.0	0.0	0.45	0.09	0.09	0.18	0.0	0.18
	July	2.8	0.34	0.0	0.0	0.0	0.33	0.28	0.48	0.47	0.0	0.0	0.10
	August	2.8	0.34	0.0	0.0	0.0	0.0	0.14	0.14	0.14	0.14	0.0	0.0
Pumping Station	March	5.0	0.61	0.0	0.20	0.0	0.0	0.40	0.60	0.0	0.0		
	April	4.9	0.59	0.09	0.0	0.09	0.0	0.0	0.0	0.0	0.0		
	May	5.0	0.60	0.0	0.0	0.0	0.0	0.09	0.0	0.0	0.52		
	June	4.7	0.56	0.18	0.09	0.0	0.0	0.0	0.0	0.09	0.23		
	July	4.7	0.56	0.0	0.0	0.0	0.0	0.0	0.09	0.0	0.0		
	August	4.9	0.59	0.14	0.0	0.0	0.0	0.28	0.0	0.0	0.0		
Distribution System	March	2.1	0.25	0.20	0.20	0.20	0.0	0.20	0.0	0.0	0.0		
	April	2.0	0.24	0.09	0.0	0.09	0.0	0.0	0.09	0.0	0.0		
	May	2.8	0.34	0.0	0.0	0.37	0.43	0.00	0.09	0.09	0.0		
	June	0.92	0.11	0.0	0.0	0.0	0.09	0.45	0.0	0.30	0.0		
	July	0.81	0.096	0.19	0.0	1.0	1.8	0.09	0.0	0.21	0.09		
	August	1.3	0.15	0.88	0.0	0.0	0.0	0.6	0.0	0.32	0.57		

TABLE 3A

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No. 3

Date 1942		Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by B. of H.	Temp. °F.	Wind Direction
July	14	1,100	1,100	1,100	30,000	70	NW
	27	4,600	1,700	4,600	2,400	78	NW
August	14	1,300	1,700	3,100	30,000	74	SW
	18	4,900	2,400	4,600	2,400	74	SW
	20	2,400	17,000	7,000	2,400	74	SW
	27	17,000	7,000	170	2,400	72	SW
Total		31,300	30,900	20,570	69,600	442	
Avg.		5,220	5,150	3,430	11,600	73.6	
		Plate Count, Bacteria per ml.					
July	14	3,330	2,250	285	165		
	27	1,080	3,300	1,850	640		
August	14	8,650	38,700	59,500	144,000		
	18	1,060	20,100	400	3,300		
	20	7,550	11,600	3,600	43,000		
	27	5,850	8,350	18,000	200		
Total		27,520	83,700	83,635	191,305		
Avg.		4,590	14,000	14,000	31,900		

TABLE 3B

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No.8

Date 1942		Standardized Procedure by		B. of H. Routine Procedure by		Temp. °F.	Wind Direction
		U.S.P.H.S.	N.W. B. of H.		B. of H.		
July	14	1,300	540	350	240	66	NW
	27	17	79	33	15	71	NW
August	14	33	33	4.5	9	71	SW
	18	220	170	240	240	71	SW
	20	2,400	460	1,600	2,400	71	SW
	27	240	240	5,400	2,400	68	SW
Total		4,210	1,522	7,627.5	5,304	418	
Avg.		702	254	1,270	884	69.6	

Plate Count, Bacteria per ml.

July	14	281	50	155	55		
	27	6	80	100	20		
August	14	3	12	18	143		
	18	18	55	18	11		
	20	48	30	54	26		
	27	260	475	3,250	925		
Total		611	702	3,595	1,180		
Avg.		102	117	599	197		

TABLE 3C

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No.11

Date 1942	Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by B. of H.	Temp. °F.	Wind Direction
July 14	330	540	540	38	71	NW
27	170	79	33	38	74	NW
August 14	4,600	5,400	5,400	30,000	72	SW
18	240	220	350	240	73	SW
20	7,000	16,000	18,000	300,000	73	SW
Total	12,340	22,239	24,323	330,316	363	
Avg.	2,470	4,450	4,860	66,100	72.6	

Plate Count, Bacteria per ml.

July 14	438	51	60	40		
27	4	44	4	6		
August 14	575	2,285	720	10,400		
18	19	195	38	25		
20	715	770	685	3,450		
Total	1,811	3,345	1,507	13,921		
Avg.	362	669	301	2,780		

TABLE 3D

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No. 14

Date 1942		Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by ... B. of H.	Temp. °F.	Wind Direction
July	14	1,100	1,600	920	240	72	NW
	27	4,600	3,500	9,200	2,400	78	NW
August	14	2,200	3,400	2,400	2,400	73	SW
	18	1,700	920	1,600	2,400	74	SW
	20	11,000	35,000	7,000	30,000	73	SW
	27	430	1,100	1,200	2,400	72	SW
Total		21,090	47,520	22,320	39,840	441	
Avg.		3,520	7,920	3,720	6,640	73.5	
		Plate Count, Bacteria per ml.					
July	14	980	230	130	170		
	27	396	555	165	315		
August	14	3,890	5,300	13,800	26,800		
	18	1,420	3,755	645	3,250		
	20	1,540	2,330	3,900	900		
	27	2,780	5,000	650	1,010		
Total		11,006	17,170	19,190	8,525		
Avg.		1,830	2,860	3,200	1,420		

TABLE 3E

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No. 17

Date 1942	Standardized Procedure by			B. of H. Routine Procedure by	Temp. °F.	Wind Direction
	U.S.P.H.S.	N.W.	B. of H.	B. of H.		
July 14	4,900	11,000	24,000	30,000	76	NW
27	33,000	22,000	17,000	30,000	82	NW
August 14	49,000	35,000	11,000	30,000	80	SW
18	64,000	54,000	7,000	30,000	81	SW
20	33,000	35,000	17,000	30,000	78	SW
27	17,000	11,000	920	240	77	SW
Total	200,900	168,000	67,920	150,240	474	
Avg.	33,500	28,000	11,300	25,000	79.0	

Plate Count, Bacteria per ml.

July 14	25,800	125,000	45,100	30,800		
27	7,450	9,900	27,500	96,000		
August 14	4,700	9,000	13,000,000	105,000		
18	141,000	28,800	34,000	32,500		
20	33,200	134,000	3,050	10,200		
27	132,000	29,000	1,580	990		
Total	344,150	335,700	13,111,230	275,490		
Avg.	57,400	56,000	2,190,000	45,900		

TABLE 3F

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No.20

Date 1942		Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by B. of H.	Temp. °F.	Wind Direction
July	14	1,300	700	450	2,400	74	NW
	27	24,000	14,000	1,600	2,400	78	NW
August	14	790	1,100	1,600	2,400	72	SW
	18	1,300	540	540	2,400	74	SW
	20	790	540	920	2,400	73	SW
	27	1,400	350	70,000	30,000	71	SW
Total		43,800	17,230	75,110	42,000	442	
Avg.		7,300	2,870	12,500	7,000	73.2	
		Plate Count, Bacteria per ml.					
July	14	10,000	2,000	1,950	4,000		
	27	10,000	4,050	34,500	9,500		
August	14	4,300	1,500	3,800	144,000		
	18	6,300	6,700	4,500	3,050		
	20	16,800	2,200	6,400	3,800		
	27	3,780	4,900	82,500	54,500		
Total		53,780	21,350	153,650	218,850		
Avg.		8,960	3,560	25,600	36,500		

TABLE 3G

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No.22

Date 1942		Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by B. of H.	Temp. °f.	Wind Direction
July	14	4,900	3,500	2,400	2,400	71	NW
	27	24,000	18,000	5,400	2,400	78	NW
August	14	3,300	2,400	5,400	2,400	72	SW
	18	4,900	9,200	5,400	2,400	73	SW
	20	33,000	3,500	1,600	2,400	72	SW
	27	490	2,200	220	2,400	71	SW
Total		70,590	38,800	20,420	14,400	437.	
Avg.		11,800	6,470	3,400	2,400	72.9	
		Plate Count, Bacteria per ml.					
July	14	3,840	1,385	1,640	1,300		
	27	1,590	5,150	9,000	8,500		
August	14	9,500	17,200	11,200	41,500		
	18	8,850	12,200	3,450	3,650		
	20	4,350	3,150	3,550	4,150		
	27	3,220	5,500	3,550	435		
Total		31,350	44,585	32,390	59,535		
Avg.		5,220	7,430	5,400	9,920		

TABLE 3H

Results of Cooperative Study of the Bacterial Quality of Raw Lake Michigan Water.

Lake Survey Series — Coliforms, M.P.N. per 100 ml. — Sampling Point No. 26

Date 1942		Standardized Procedure by U.S.P.H.S.	Standardized Procedure by N.W.	Standardized Procedure by B. of H.	B. of H. Routine Procedure by B. of H.	Temp. °F.	Wind Direction
July	14	1,700	920	700	240	72	NW
	27	22,000	11,000	11,000	2,400	78	NW
August	14	31,000	35,000	35,000	300,000	74	SW
	18	24,000	54,000	9,200	30,000	74	SW
	20	33,000	54,000	17,000	9,500	71	SW
Total		91,900	154,920	72,900	342,140	369	
Avg.		18,400	31,000	14,600	68,400	73.8	

Plate Count, Bacteria per ml.

July	14	1,050	220	285	175		
	27	1,080	2,700	1,050	600		
August	14	7,700	10,400	45,000	8,200		
	18	375	20,500	4,450	770		
	20	9,650	4,650	3,150	4,600		
Total		20,455	38,370	53,915	14,345		
Avg.		4,090	7,670	10,800	2,870		

opportunity for observations on the accuracy of the Chicago Board of Health results as compared with those from the other two laboratories.

During the course of the study 106 master samples of Dunne Crib intake waters were collected by the Public Health Service. These master samples were broken down into seven sub-samples, four samples without any treatment, designated as "regular" and three samples treated with thiosulphate*, designated as "thio-treated" in the amount specified in Standard Methods for its use as a dechlorinating agent. Of the four "regular" sub-samples, one was distributed to each of the three cooperating laboratories by the Public Health Service collector and one was left at the Crib for subsequent delivery to the Chicago Board of Health laboratory by their routine carrier. At the same time one of the "thio-treated" sub-samples was delivered to each of the cooperating laboratories by the Public Health Service collector. Portions of samples delivered to the Chicago Board of Health laboratory were of greater volume than the others in order to provide sufficient quantities for their examination by both the standardized and routine procedures.

The results obtained from these 106 Dunne Crib samples by the three cooperating laboratories using the standardized procedure are presented in the form of weekly averages in Table 4A for the

(*) This thiosulphate treatment procedure was carried out, although there was no chlorine in the Dunne Crib intake samples, because in the opinion of the Chicago Board of Health laboratory the addition of thiosulphate had a marked effect, at times, on the bacterial results obtained.

"regular" samples and in Table 4B for the "thio-treated" portions. The maximum coliform indices obtained in the Public Health Service laboratory from any sample during each week are also presented in these tables.

(Insert Tables 4A and 4B)

Inspection of the coliform data of Table 4A indicates that in 11 of the 24 weekly averages there is excellent agreement between the results obtained by the three laboratories. Of the remaining 13 averages those of the Northwestern University laboratory were the highest in one instance, occupied a median position in seven cases, and were the lowest five times. Similarly the results of the Chicago laboratory showed four high, two median and seven low, and the Public Health Service, eight high, four median and one low.

Corresponding observations on the coliform data of Table 4B show that excellent agreement exists between the results obtained by the three laboratories in six of the 24 weeks. For the remaining 18 weeks the Northwestern University laboratory produced four high, six median and eight low results, the Chicago laboratory six high, seven median and five low, and the Public Health Service laboratory, eight high, five median and five low.

A better conception of the correlation between these results based on the coliform data at the three laboratories, can be obtained by an inspection of Charts I and II where the data of Tables 4A and 4B have been plotted on semilogarithmic paper. In

TABLE 4A

Weekly Average Bacterial Results Obtained from Samples of Water from Dunne Crib.
(Not treated with Thiosulphate)

Week Ending 1942		Plate Count, Bact. per ml.			Coliforms, M.P.N. per 100 ml.			
		N.W.[1]	B. of H.[2]	P.H.S.[3]	N.W.[1]	B. of H.[2]	P.H.S.[3]	Maximum Coliforms by P.H.S.
March	20	7.	6.	1.	2.2	1.8	2.2	4.5
	27	198.	186.	158.	36.7	10.5	27.3	130.0
April	3	90.	196.	45.	7.4	13.4	14.0	49.0
	10	54.	34.	7.	1.2	2.3	2.2	4.5
	17	48.	60.	34.	38.3	116.0	108.0	490.0
	24	12.	22.	4.	2.0	1.9	1.7	4.5
May	1	1200.	1050.	846.	51.8	30.2	55.6	170.0
	8	427.	1360	201.	2.6	8.1	5.1	13.0
	15	303.	86.	84.	175.0	89.6	200.0	790.0
	22	64.	31.	102.	19.1	16.4	53.8	170.0
	29	41.	25.	74.	64.8	55.0	209.0	790.0
June	5	34.	38.	140.	20.9	88.8	25.9	49.0
	12	22.	7.	8.	36.3	43.8	72.4	110.0
	19	23.	17.	4.	27.2	19.9	51.2	170.0
	26	35.	14.	16.	214.0	258.0	370.0	1700.0
July	3	15.	49.	36.	28.2	21.5	73.5	210.0
	10	11.	18.	21.	5.1	8.3	17.4	49.0
	17	222.	124.	289.	1110.0	1590.0	1440.0	4900.0
	24	24.	3.	9.	25.7	12.9	52.5	130.0
	31	33.	2.	8.	8.2	12.1	15.1	33.0
August	7	182.	112.	221.	465.0	865.0	1040.0	3300.0
	14	31.	9.	6.	93.0	90.8	160.0	330.0
	21	146.	4.	27.	200.0	134.0	262.0	490.0
	28	715	186.	499.	1210.0	1500.0	628.0	1700.0

1 - N.W. - Results Obtained by Northwestern University Laboratory.
2 - B. of H.- Results Obtained by Chicago Health Department Laboratory.
3 - P.H.S. - Results Obtained by U. S. Public Health Service Laboratory.

TABLE 4B

Weekly Average Bacterial Results Obtained from Samples of Water from Dunne Crib.
(Treated with Thiosulphate)

Week Ending 1942	Plate Count, Bact. per ml.			Coliforms, M.P.N. per 100 ml.			
	N.W.[1]	B. of H.[2]	P.H.S.[3]	N.W.[1]	B. of H.[2]	P.H.S.[3]	Maximum Coliforms by P.H.S.
March 20	8.	10.	1.	1.3	0.0	1.3	2.0
27	206.	289.	182.	31.0	28.9	14.4	64.0
April 3	37.	137.	57.	12.6	13.1	17.9	49.0
10	119.	35.	5.	1.7	5.4	2.7	6.8
17	51.	51.	49.	31.0	100.0	73.1	330.0
24	12.	36.	4.	0.9	3.0	4.7	17.0
May 1	1560.	1470.	1160.	101.0	63.0	126.0	330.0
8	571.	403.	203.	6.8	10.6	4.7	7.8
15	435.	188	227.	136.0	53.6	198.0	790.0
22	64.	40.	96.	42.7	20.6	45.7	170.0
29	67.	5.	92.	27.8	58.7	210.0	790.0
June 5	26.	48.	151.	28.4	65.8	50.5	130.0
12	30.	18.	11.	41.2	83.0	79.7	170.0
19	31.	28.	9.	25.2	25.5	38.2	79.0
26	49.	44.	70.	351.0	367.0	507.0	2400.0
July 3	47.	54.	86.	17.5	43.2	49.4	170.0
10	28.	21	36.	9.3	7.2	25.0	79.0
17	263.	178.	350.	1340.0	1160.0	1410.0	4900.0
24	44.	4.	15.	25.1	27.7	59.1	130.0
31	22.	22.	32.	27.0	33.0	20.4	49.0
August 7	233.	158.	286.	852.0	1520.0	670.0	790.0
14	79.	76.	49.	140.0	122.0	120.0	240.0
21	272.	32.	49.	160.0	144.0	310.0	490.0
28	795.	242.	780.	2320.0	1020.0	715.0	1700.0

1 - N.W. - Results Obtained by Northwestern University Laboratory.
2 - B. of H. - Results Obtained by Chicago Health Department Laboratory.
3 - P.H.S. - Results Obtained by U. S. Public Health Service Laboratory.

general it appears that excellent agreement exists between the results obtained by the three laboratories from the examination of these samples by the standardized procedure.

(Insert Charts I and II)

A similar study of the plate count results presented in these two tables discloses the same general agreement. In the case of the plate counts, however, it should be noted that during the first part of the study, particularly the first two months, both Northwestern University and the Chicago Board of Health laboratory operated their 37°C. incubators at 0.5 to 1.5 degrees below normal. Such reductions in incubator temperature, though not affecting the results of the coliform examinations in the least, would in many instances materially increase the plate count results.

With regard to the bacterial quality of the lake water at this sampling point, it will be noted that the weekly average coliform content exceeded 50 per 100 ml. for the week ending April 17, and that thereafter during the course of the study the trend of the weekly average coliform content was toward a steady and definite increase, for the week ending July 17, reaching a high of 4900 per 100 ml. as observed by the Public Health Service laboratory.

2. A comparison of the bacterial results obtained by the Chicago Board of Health laboratory using the standardized procedure and their routine procedure in the duplicate examination of the same samples.

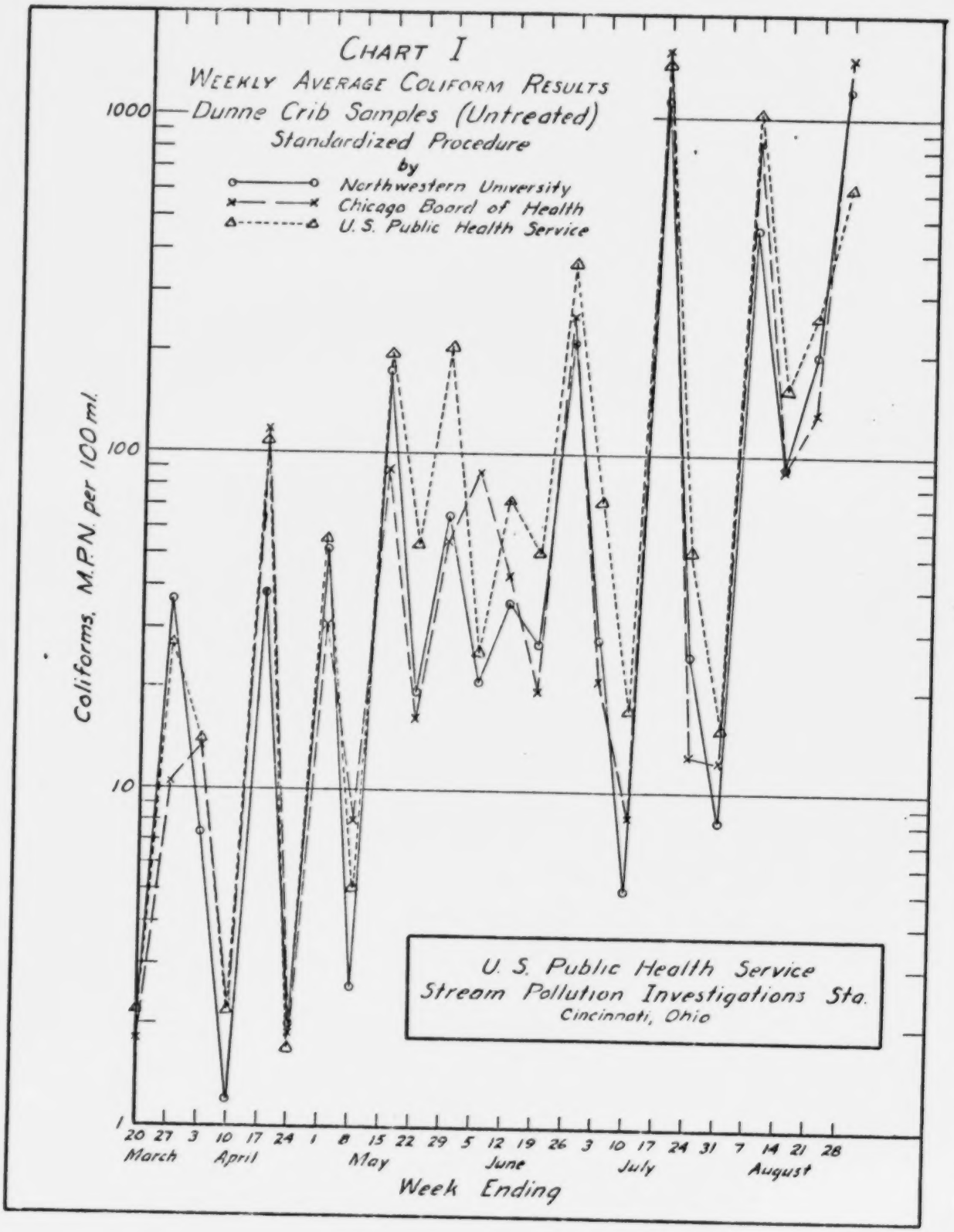


CHART I
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples (Untreated)
Standardized Procedure
by
Northwestern University
Chicago Board of Health
U.S. Public Health Service
1000
100
10
1
Coliforms, M.P.N. per 100 ml.
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March
April
May
June
July
August
Week Ending
U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio

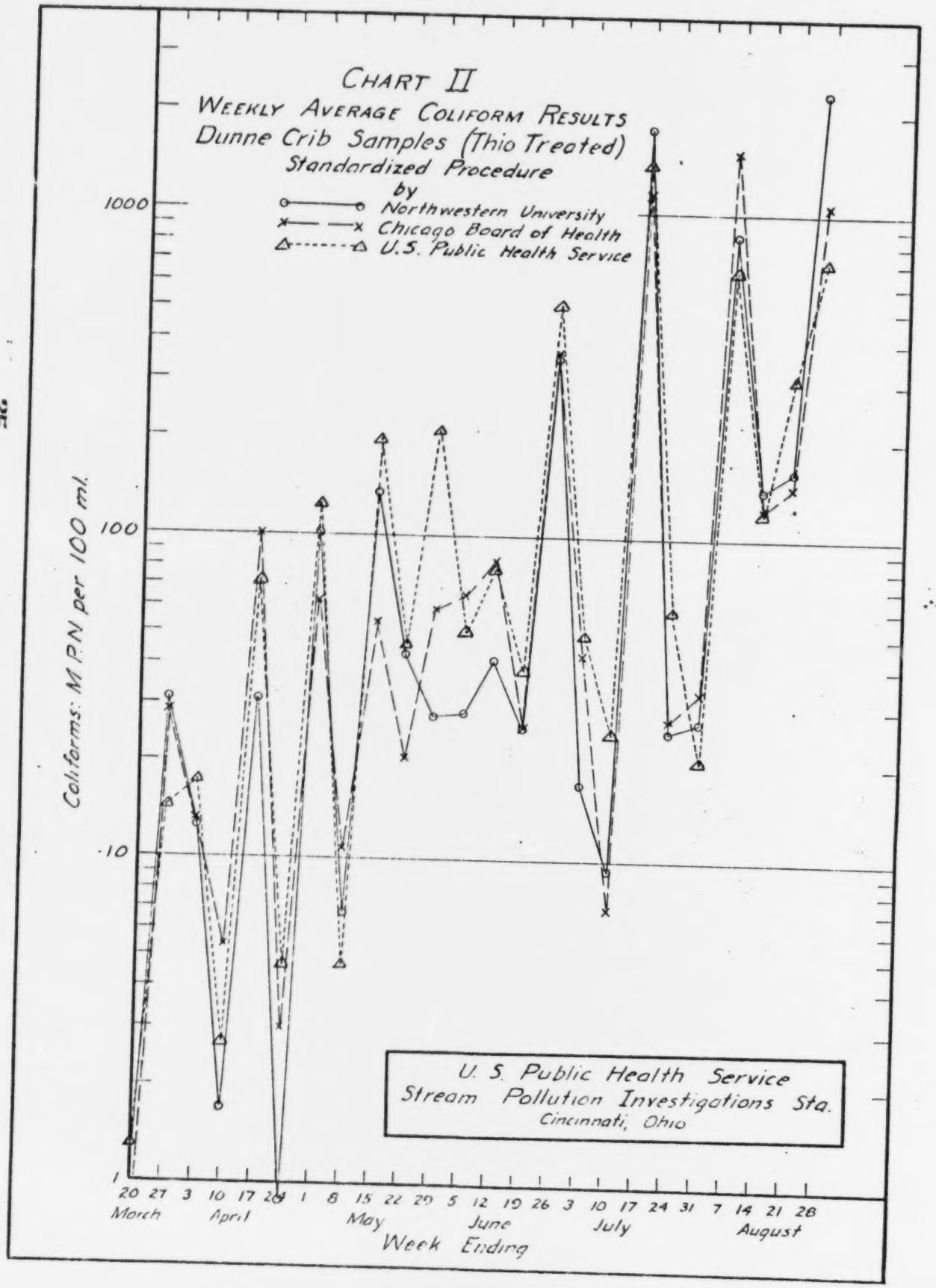


CHART II
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples (Thio Treated)
Standardized Procedure
by
Northwestern University
Chicago Board of Health
U.S. Public Health Service
1000
100
10
1
Coliforms: M.P.N. per 100 ml.
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March
April
May
June
July
August
Week Ending
U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio

As stated above, the portions of the master samples collected by the Public Health Service which were delivered to the Chicago Board of Health laboratory, were of greater volume to provide them with a sufficient quantity of water for examination by both the standardized procedure and by their routine procedure. There are two main differences between these procedures. First, for the coliform determination with the standardized procedure five tubes were planted of each size portion examined, while with the routine procedure five tubes were planted of the largest portion of sample examined (usually 10 ml.) and one tube only was planted of each following dilution. Second, the media used for the standardized procedure were all prepared from standard dehydrated stock of the same lot numbers as supplied to all three laboratories concerned, while with the routine procedure all media were prepared from individual basic ingredients obtained by the local laboratory.

As the results obtained by the cooperating laboratories using the standardized procedure have been compared, it seemed appropriate now to restrict the comparison of results obtained by the two procedures to data secured by the Chicago Board of Health laboratory. This would eliminate any variables peculiar to conditions in any one laboratory and for the purpose of this comparison would limit the variables to those of the two procedures. Consequently, the weekly average data obtained by the Chicago Board of Health laboratory from the examination of Dunne Crib intake samples by the standardized and also by their routine procedure have been tabulated and are presented in Table 5A for the

"regular" Dunno Crib samples and in Table 5B for the "thio-treated" Dunno Crib samples. These data, based on the coliform findings, are also shown graphically on semilogarithmic paper in Charts III-A and III-B, respectively.

(Insert Tables 5A and 5B, and Charts III-A and III-B)

Considering first the results from the regular samples, presented in Table 5A and Chart III-A, it will be observed that in general fairly good agreement exists between the data obtained by the two procedures. For the plate counts the standardized procedure gives the higher average in 18 of the 24. In only one instance, however, namely for the week ending May 8, is the divergence of any considerable magnitude. The difference in this instance was produced by one abnormal result, obtained on May 8, of 4050 by the Board of Health laboratory using the standardized procedure when the counts by their routine procedure and the counts of the other two laboratories for this sample were 100 or less per ml.

In the case of the coliform results from the same samples the condition is reversed, the routine procedure giving the higher averages in 16 of the 24 weeks. Here again the difference is marked in only two instances, namely the averages for the weeks ending May 1 and August 14.

When the results with the thiosulphate treated samples (Table 5B and Chart III-B) are studied, it is observed that between the plate counts approximately the same agreement exists as was noted for the corresponding results from the "regular" portions.

TABLE 5A

Weekly Averages Bacterial Results Obtained by Chicago Board of Health Laboratory from Examination of Dunne Crib Samples (Regular) by (1)Standardized Procedure and (2)their Routine* Procedure.

Week Ending 1942	Plate Count, Bacteria per ml. (1)Standardized Procedure	(2)Routine Procedure	Procedure giving high result	Coliforms, M.P.N. per 100 ml. (1)Standardized Procedure	(2)Routine Procedure	Procedure giving high result
March						
20	6.	8.	2	1.8	0.0	1
27	186.	184.	1	10.5	28.2	2
April						
3	196.	102.	1	13.4	56.1	2
10	34.	29.	1	2.3	1.8	1
17	60.	25.	1	116.0	58.0	1
24	22.	7.	1	1.9	2.2	2
May						
1	1050.	628.	1	30.2	155.0	2
8	1360.	130.	1	8.1	11.8	2
15	86.	42.	1	89.6	64.0	1
22	31.	10.	1	16.4	28.8	2
29	25.	21.	1	55.0	67.2	2
June						
5	38.	34.	1	88.8	77.0	1
12	7.	4.	1	43.8	73.8	2
19	17.	7.	1	19.9	33.4	2
26	14.	29.	2	258.0	545.0	2
July						
3	49.	36.	1	21.5	63.8	2
10	18.	3.	1	8.3	19.6	2
17	124.	109.	1	1590.0	1260.0	1
24	3.	3.	-	12.9	14.8	2
31	2.	2.	-	12.1	15.0	2
August						
7	112.	45.	1	865.0	1320.0	2
14	9.	12.	2	90.8	623.0	2
21	4.	4.	-	134.0	130.0	1
28	186.	131.	1	1500.0	679.0	1

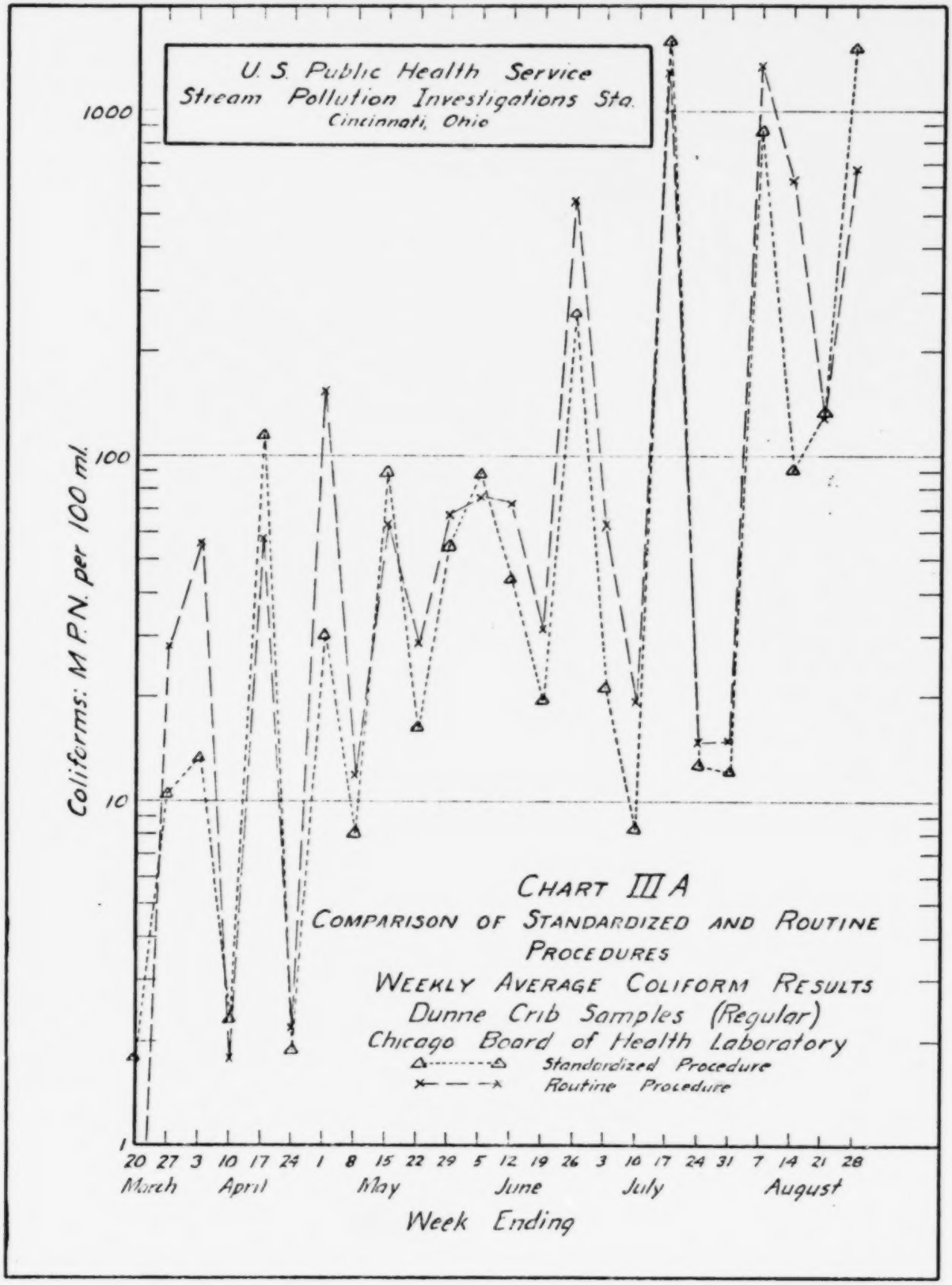
*Note: The principal differences in the two procedures were; in the standardized procedure for coliform determinations five tubes were planted at each dilution and standard dehydrated media of the same lot numbers were used, while in the Chicago B. of H. routine procedure five tubes were planted of the largest amount of sample, with one tube only at each following dilution and the media used were prepared in the laboratory from basic ingredients as needed.

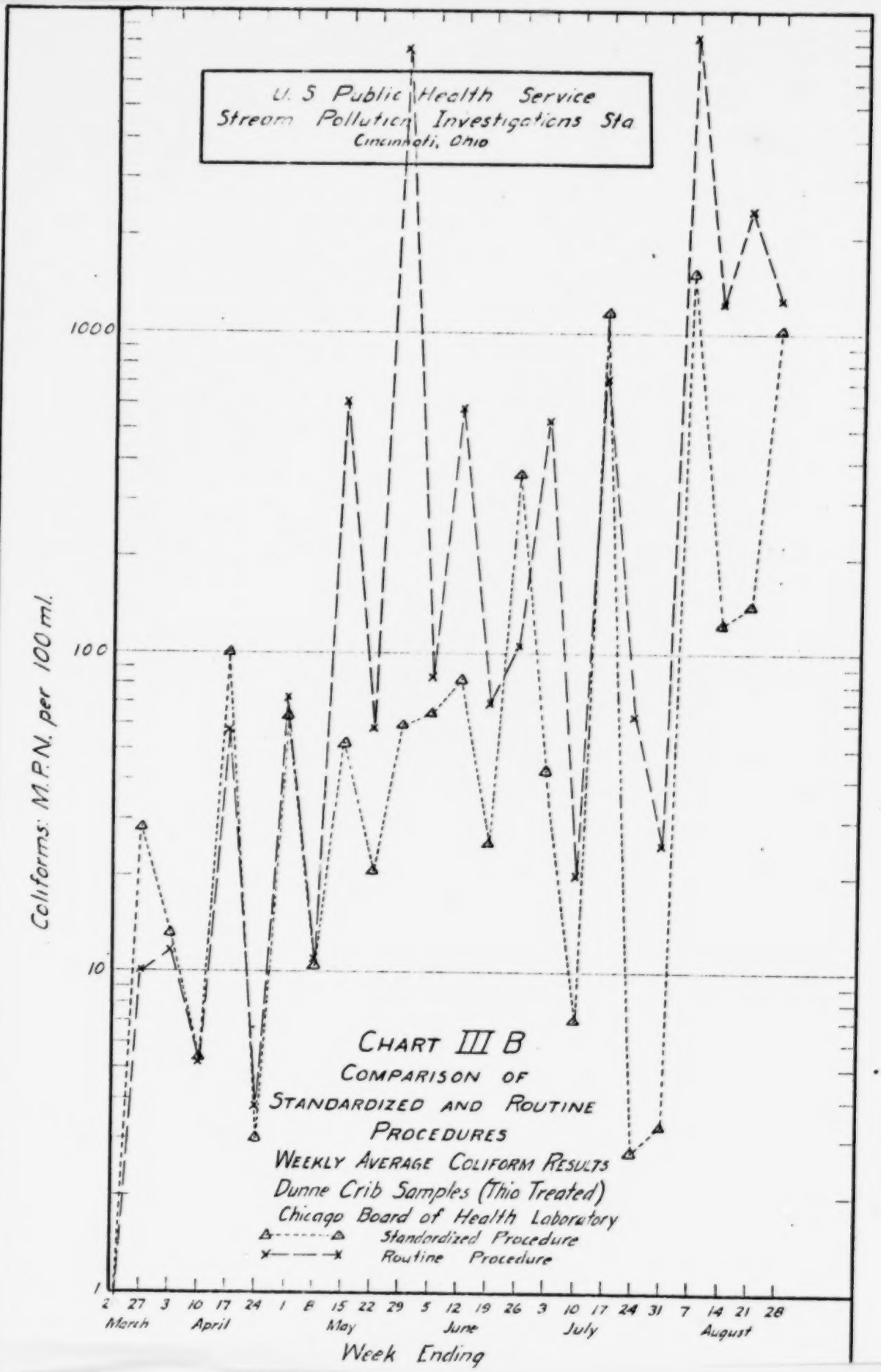
TABLE 5B

Weekly Averages Bacterial Results Obtained by Chicago Board of Health Laboratory from Examination of Dunne Crib Samples (thiosulphate treated) by (1)Standardized Procedure and (2)Routine* Procedure.

Week Ending 1942	Plate Counts Bacteria per ml. (1)Standardized Procedure	(2)Routine Procedure	Procedure giving high result	Coliforms M.P.N. per 100 ml. (1)Standardized Procedure	(2)Routine Procedure	Procedure giving high result
March						
20	10.	5.	1	0.0	0.0	-
27	239.	244.	1	28.9	10.0	1
April						
3	137.	84.	1	13.1	11.6	1
10	35.	24.	1	5.4	5.2	1
17	51.	39.	1	100.0	57.6	1
24	36.	10.	1	3.0	3.8	2
May						
1	1470.	1210.	1	63.0	73.2	2
8	403.	162.	1	10.6	11.0	2
15	188.	90.	1	53.6	606.0	2
22	40.	13.	1	20.6	58.2	2
29	5.	24.	2	58.7	7500.0	2
June						
5	48.	33.	1	65.8	84.2	2
12	18.	13.	1	83.0	588.0	2
19	29.	17.	1	25.5	69.4	2
26	44.	59.	2	367.0	104.0	1
July						
3	54.	39.	1	43.2	532.0	2
10	21.	17.	1	7.2	20.4	2
17	173.	141.	1	1160.0	723.0	1
24	4.	6.	2	27.7	63.4	2
31	22.	13.	1	33.0	25.0	1
August						
7	158.	52.	1	1520.0	8220.0	2
14	76.	59.	1	122.0	1210.0	2
21	32.	14.	1	140.0	2400.0	2
28	242.	201.	1	1020.0	1270.0	2

*Note: The principal differences in the two procedures were; in the standardized procedure for coliform determinations five tubes were planted at each dilution and standard dehydrated media were used, while in the Chicago B. of H. routine procedure five tubes were planted of the largest amount of sample with one tube only at each following dilution and the media used were prepared in the laboratory from the basic ingredients as needed.


U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
1000
100
10
1
20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March April May June July August
Week Ending
CHART III A
COMPARISON OF STANDARDIZED AND ROUTINE PROCEDURES
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples (Regular)
Chicago Board of Health Laboratory
Standardized Procedure
Routine Procedure


U. S Public Health Service
Stream Pollution Investigations Sta
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
1000
100
10
1
2 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March
April
May
June
July
August
Week Ending
CHART III B
COMPARISON OF
STANDARDIZED AND ROUTINE
PROCEDURES
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples (Thio Treated)
Chicago Board of Health Laboratory
Standardized Procedure
Routine Procedure

That is, there is, without exception, fair agreement between the average counts obtained by the two procedures, but the standardized procedure gives the higher average in 21 of the 24 weekly averages. When the coliform results are considered, however, an entirely different condition is observed. The routine procedure gives the higher result in 16 of 23 averages and in seven of these (namely, the averages for the weeks ending May 15, May 29, June 12, July 3, and August 7, 14, and 21, 1942), the averages are abnormally high. The criterion for an "abnormally high" result as used here is considered an average which exceeds its corresponding result by five-fold or more. The reasons for these variations are not apparent. Possible explanations will be discussed below when similar data shown in Table 7D and Chart V-D are presented.

3. A comparison of the results obtained from samples delivered to the laboratory for examination soon after collection by Public Health Service carrier with the results obtained from aliquot portions of the same samples held at the point of collection for later delivery to the laboratory by routine Board of Health carrier. ("Crib Hold" samples).

Although there is considerable evidence in the literature against the holding or storage of samples after collection and prior to examination, the Standard Methods sets definite limits for such procedures, this item was included in the study because at Chicago it was standard practice to collect samples daily at Dunne Crib at regular intervals and hold these samples at the

Crib until they were delivered to the Board of Health laboratory by their routine carrier. At times, particularly during the winter and stormy periods when travel by boat is precarious, these holding periods become very excessive, seven to ten days. Available evidence in the literature shows that coliform results from such samples will tend to be low and the plate count results may be either high or low, depending on the nature of the sample, the time and the conditions of storage.

In this study the Chicago Board of Health laboratory made this comparison over a period of 22 weeks, using their routine procedure, examining duplicates of samples of Dunne Crib intake water, one portion of each delivered to the laboratory soon after collection by the Public Health Service carrier, and the other portion delivered by their routine carrier. The period of "holding" at the Crib for samples delivered by the Board of Health carrier during this study varied from none to six days. The interval between the time of collection and the time of delivery to the laboratory for the samples delivered by the Public Health Service carrier would not exceed four hours, and all samples were iced during transit after May 5. The results obtained in this comparison are presented in Table 6 and the coliform trends are shown in Chart IV plotted on semilogarithmic paper.

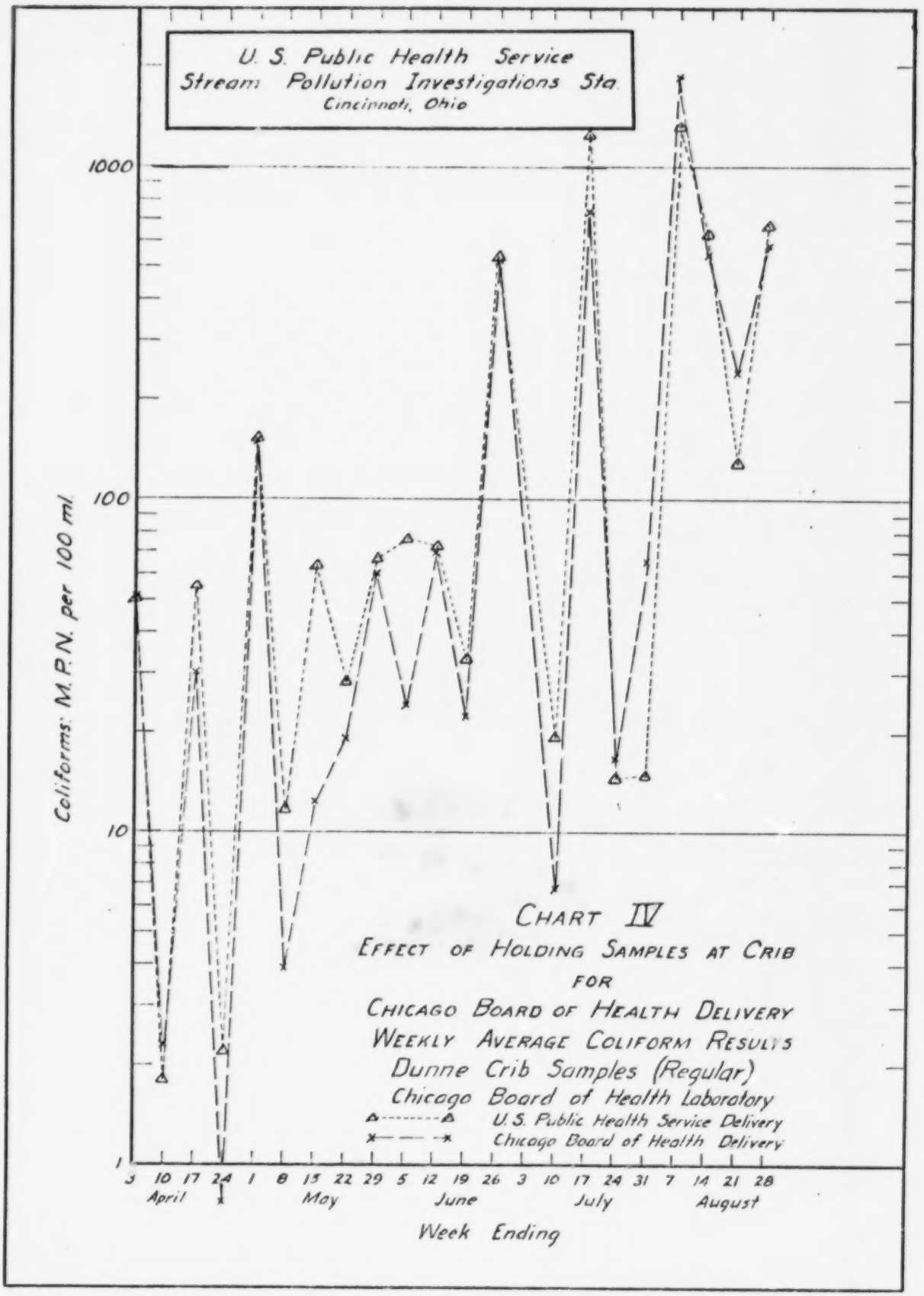
(Insert Table 6 and Chart IV)

In general, for the coliform results the difference between the two sets of data are not great. The samples delivered immediately yielded the higher result, however, in 16 out of the 22

TABLE 6

Effect of Holding Samples Prior to Examination.
Results by Chicago B. of H. Laboratory from Untreated Dunne Crib Samples,
(1)Portion Delivered by U.S.P.H.S., and
(2)Portion held at Crib for Chicago B. of H. Routine Delivery

Week Ending 1942	Plate Count, Bacteria per ml.		Coliforms, M.P.N. per 100 ml.	
	U.S.P.H.S. Delivery	B. of H. Delivery	U.S.P.H.S. Delivery	B. of H. Delivery
April 3	102.	156.	51.6	51.8
10	29.	4.	1.8	2.6
17	25.	41.	56.0	30.4
24	7.	17.	2.2	0.8
May 1	628.	670.	155.0	153.0
8	130.	115.	11.8	3.8
15	42.	76.	64.0	12.2
22	10.	2330.	28.8	19.0
29	21.	17.	67.2	61.5
June 5	34.	13.	77.0	24.0
12	4.	2.	73.8	69.2
19	7.	3.	33.4	22.2
26	29.	87.	545.0	533.0
July 3	36.	136.	63.8	60.8
10	3.	96.	19.6	6.8
17	109.	68.	1260.0	730.0
24	3.	3.	14.8	16.8
31	2.	18000.	15.0	65.4
August 7	45.	104.	1320.0	1860.0
14	12.	5.	623.0	542.0
21	4.	16.	130.0	240.0
28	131.	761.	673.0	584.0


U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio
1000
100
10
1
Coliforms: M.P.N. per 100 ml.
3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
April
May
June
July
August
Week Ending
CHART IV
EFFECT OF HOLDING SAMPLES AT CRIB
FOR
CHICAGO BOARD OF HEALTH DELIVERY
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples (Regular)
Chicago Board of Health Laboratory
U.S. Public Health Service Delivery
Chicago Board of Health Delivery

averages and in three of the six cases in which they were low the margin of difference was very slight. With the plate count results, on the contrary, much wider variations are to be found. The quickly delivered samples gave high averages in eight instances, low in 13, and exactly the same in one. The wide variations which may be expected for plate counts from samples treated in this manner are observed in the averages for the weeks ending May 22, July 31 and August 28.

4. Observations on the effect of treating raw Lake Michigan water (Dunne Crib samples) with a dechlorinating agent, thiosulphate.

This phase of the study was undertaken, as previously explained, because it was the opinion of personnel of the Chicago Board of Health laboratory that the addition of thiosulphate to these samples, at times, had a very marked effect on the bacterial results obtained. In this study aliquot parts of duplicate portions of Dunne Crib samples (one portion, not treated with thiosulphate, and one portion treated with thiosulphate) were examined by each of the three laboratories as follows:

(a) Public Health Service laboratory, using the standardized procedure

(b) Northwestern University laboratory, using the standardized procedure

(c) Chicago Board of Health laboratory, using the standardized procedure

(d) Chicago Board of Health laboratory, using their routine procedure.

The results obtained are presented as weekly averages in Tables 7A, 7B, 7C and 7D, respectively. The data of the coliform results from these tables are shown on Charts V-A, V-B, V-C and V-D.

(Insert Tables 7A, 7B, 7C and 7D, and Charts V-A, V-B, V-C and V-D)

Considering first the plate count results obtained with both the standardized and the routine procedures, it is noted that while there is in general fair agreement between the results obtained from the two sets of samples, the averages for the thiosulphate treated portions are consistently higher. That is, of the 24 weekly averages under consideration the thiosulphate treated portions show the higher averages in 21, 21, 20 and 20 instances, respectively. The reason for this is not apparent.

Turning now to the coliform averages obtained with the standardized procedure, Tables 7A, 7B and 7C, very fair agreement is observed in all instances. That is, of 24 weekly averages the Public Health Service results show the non-thiosulphate treated averages to be high in 11, the Northwestern University averages high in 10, and the Chicago Board of Health high in 9. In no instance is there a wide discrepancy between any two weekly averages. This correlation is visualized better by an inspection of Charts V-A, V-B and V-C.

When the coliform results obtained with the routine procedure are studied in Table 7D and Chart V-D, an entirely different situation is observed. The thiosulphate treated portions yield

TABLE 7A

Comparison of Effect of Treating Dunne Crib Samples with Thiosulphate. Weekly Average Bacterial Results Obtained by P.H.S. Laboratory Using Standardized Procedure.

Week Ending 1942	Plate Counts, Bacteria per ml.		Coliforms, M.P.N. per 100 ml.	
	Untreated	Treated	Untreated	Treated
March 20	1.	1.	2.2	1.3
27	158.	182.	27.3	14.4
April 3	45.	57.	14.0	17.9
10	7.	5.	2.2	2.7
17	34.	49.	108.0	73.1
24	4.	4.	1.7	4.7
May 1	846.	1160.	55.6	126.0
8	201.	203.	5.1	4.7
15	84.	227.	199.0	198.0
22	102.	96.	53.8	45.7
29	74.	92.	209.0	210.0
June 5	140.	151.	25.9	50.5
12	8.	11.	72.4	79.9
19	4.	9.	51.2	38.2
26	16.	70.	370.0	507.0
July 3	36.	86.	70.9	49.4
10	21.	36.	17.4	25.0
17	289.	350.	1440.0	1410.0
24	9.	15.	52.5	59.1
31	8.	32.	15.1	20.4
August 7	221.	286.	1040.0	670.0
14	6.	49.	160.0	120.0
21	27.	49.	262.0	310.0
28	499.	780.	627.0	715.0

TABLE 7B

Comparison of Effect of Treating Dunne Crib Samples with Thiosulphate. Weekly Average Bacterial Results Obtained by Northwestern University Using Standardized Procedure.

Week Ending 1942	Plate Count, Bacteria per ml.		Coliforms, M.P.N. per 100 ml.	
	Untreated	Treated	Untreated	Treated
March 20	7.	8.	2.2	1.3
27	198.	206.	36.7	31.0
April 3	90.	87.	7.4	12.6
10	54.	119.	1.2	1.7
17	48.	51.	38.3	31.0
24	12.	12.	2.0	0.9
May 1	1200.	1560.	51.8	101.0
8	427.	571.	2.6	6.8
15	303.	435.	175.0	136.0
22	64.	64.	19.1	42.7
29	41.	67.	64.8	27.8
June 5	34.	26.	20.9	28.4
12	22.	30.	36.3	41.2
19	23.	31.	27.2	25.2
26	35.	49.	214.0	351.0
July 3	15.	47.	28.2	17.5
10	11.	28.	5.1	9.3
17	222.	263.	1110.0	1840.0
24	24.	44.	25.7	25.1
31	33.	24.	8.2	27.0
August 7	182.	233.	465.0	852.0
14	31.	79.	93.0	140.0
21	146.	272.	200.0	160.0
28	715.	795.	1210.0	2320.0

TABLE 7C

Comparison of Effect of Treating Dunne Crib Samples with Thiosulphate. Weekly Average Bacterial Results Obtained by Chicago S. of H. Laboratory Using Standardized Procedure.*

Week Ending 1942	Plate Count Bacteria per ml.		Coliforms, M.P.N. per 100 ml.	
	Untreated	Treated	Untreated	Treated
March 20	6.	10.	1.8	0.0
27	186.	289.	10.5	28.9
April 3	196.	137.	13.4	13.1
10	34.	35.	2.3	5.4
17	60.	51.	116.0	100.0
24	22.	36.	1.9	3.0
May 1	1050.	1470.	30.2	63.0
8	1360.	403.	8.1	10.6
15	86.	188.	89.6	53.6
22	31.	40.	16.4	20.6
29	25.	5.	59.0	58.7
June 5	38.	48.	88.8	65.8
12	7.	18.	43.8	83.0
19	17.	29.	19.9	25.5
26	14.	44.	258.0	367.0
July 3	49.	54.	21.5	43.2
10	18.	21.	8.3	7.2
17	124.	178.	1590.0	1160.0
24	3.	4.	12.9	27.7
31	2.	22.	12.1	33.0
August 7	112.	158.	865.0	1520.0
14	9.	76.	90.8	122.0
21	4.	32.	134.0	144.0
28	186.	242.	1500.0	1020.0

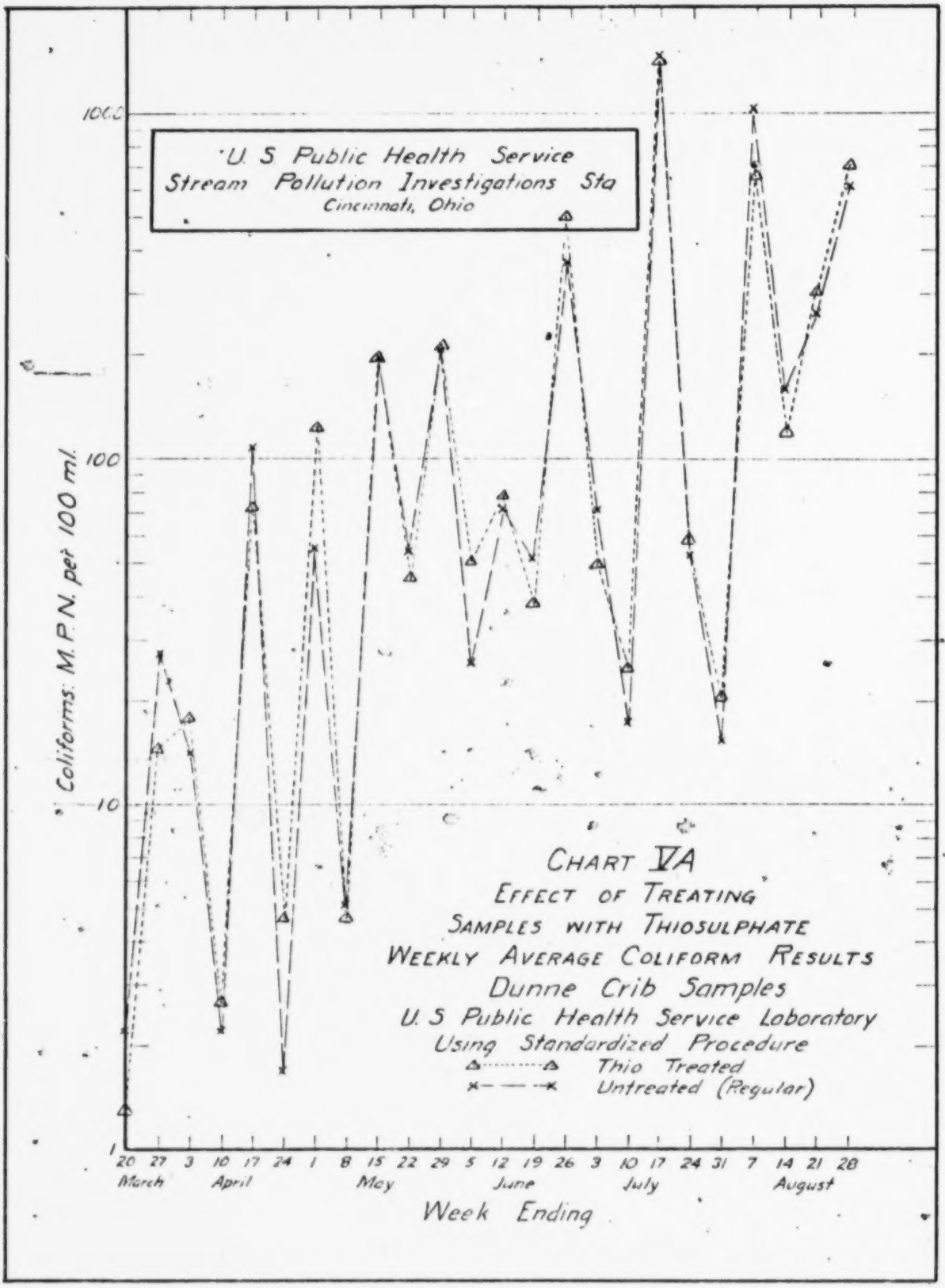
(*) See note Table 7D

TABLE 7D

Comparison of Effect of Treating Dunne Crib Samples with Thiosulphate. Weekly Average Bacterial Results Obtained by Chicago B. of H. Laboratory Using Chicago B. of H. Routine Procedure*

Week Ending 1942	Plate Counts, Bacteria per ml.		Coliforms, M.P.N. per 100 ml.	
	Untreated	Treated	Untreated	Treated
March 20	8.	5.	0.0	0.0
27	184.	244.	28.2	10.0
April 3	102.	84.	51.6	11.6
10	29.	24.	1.8	5.2
17	25.	39.	58.0	57.6
24	7.	10.	2.2	3.8
May 1	628.	1210.	155.0	73.2
8	130.	162.	11.8	11.0
15	42.	90.	64.0	606.0
22	10.	13.	28.8	58.6
29	21.	24.	67.2	7500.0
June 5	34.	33.	77.0	84.2
12	4.	13.	73.8	588.0
19	7.	17.	33.4	69.4
26	29.	59.	545.0	104.0
July 3	36.	39.	63.8	532.0
10	3.	17.	19.6	20.4
17	109.	141.	1260.0	723.0
24	3.	6.	14.8	63.4
31	2.	13.	15.0	25.0
August 7	45.	52.	1320.0	8220.0
14	12.	59.	623.0	1213.0
21	4.	14.	130.0	2400.0
28	131.	201.	679.0	1270.0

(*)Note. The principal differences in the two procedures were; in the Standardized procedure (See Table 7C) for coliform determinations five tubes were planted at each dilution and standard dehydrated media were used, while in the Chicago B. of H. routine procedure five tubes were planted of the largest amount of sample, with one tube only at each following dilution and the media used were prepared in the laboratory from basic ingredients as needed.


U. S. Public Health Service
Stream Pollution Investigations Sta
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
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20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
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Week Ending
CHART VA
EFFECT OF TREATING
SAMPLES WITH THIOSULPHATE
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples
U. S Public Health Service Laboratory
Using Standardized Procedure
Thio Treated
Untreated (Regular)

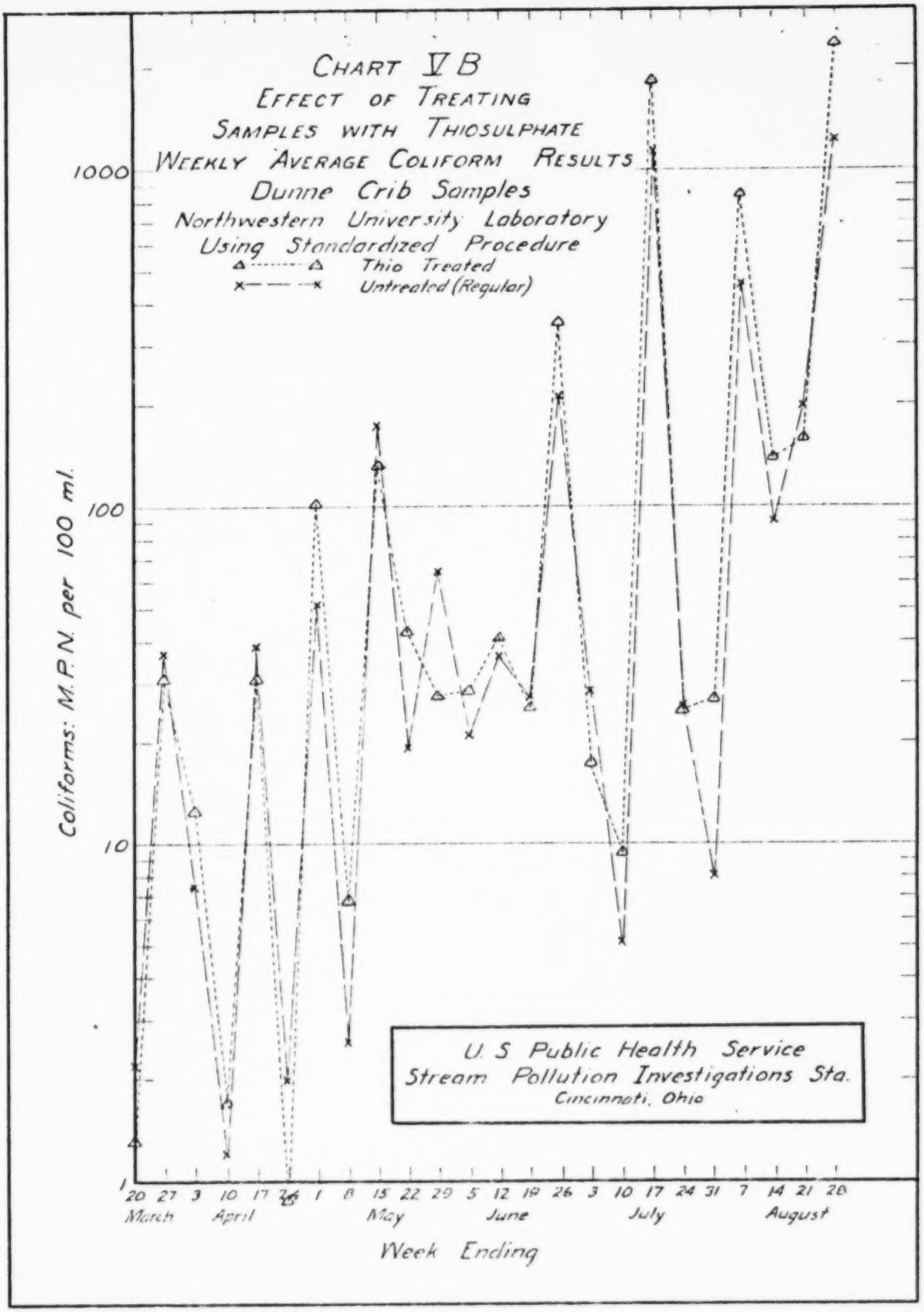
CHART V B
EFFECT OF TREATING
SAMPLES WITH THIOSULPHATE
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples
Northwestern University Laboratory
Using Standardized Procedure
Thio Treated
Untreated (Regular)
Coliforms: M.P.N. per 100 ml.
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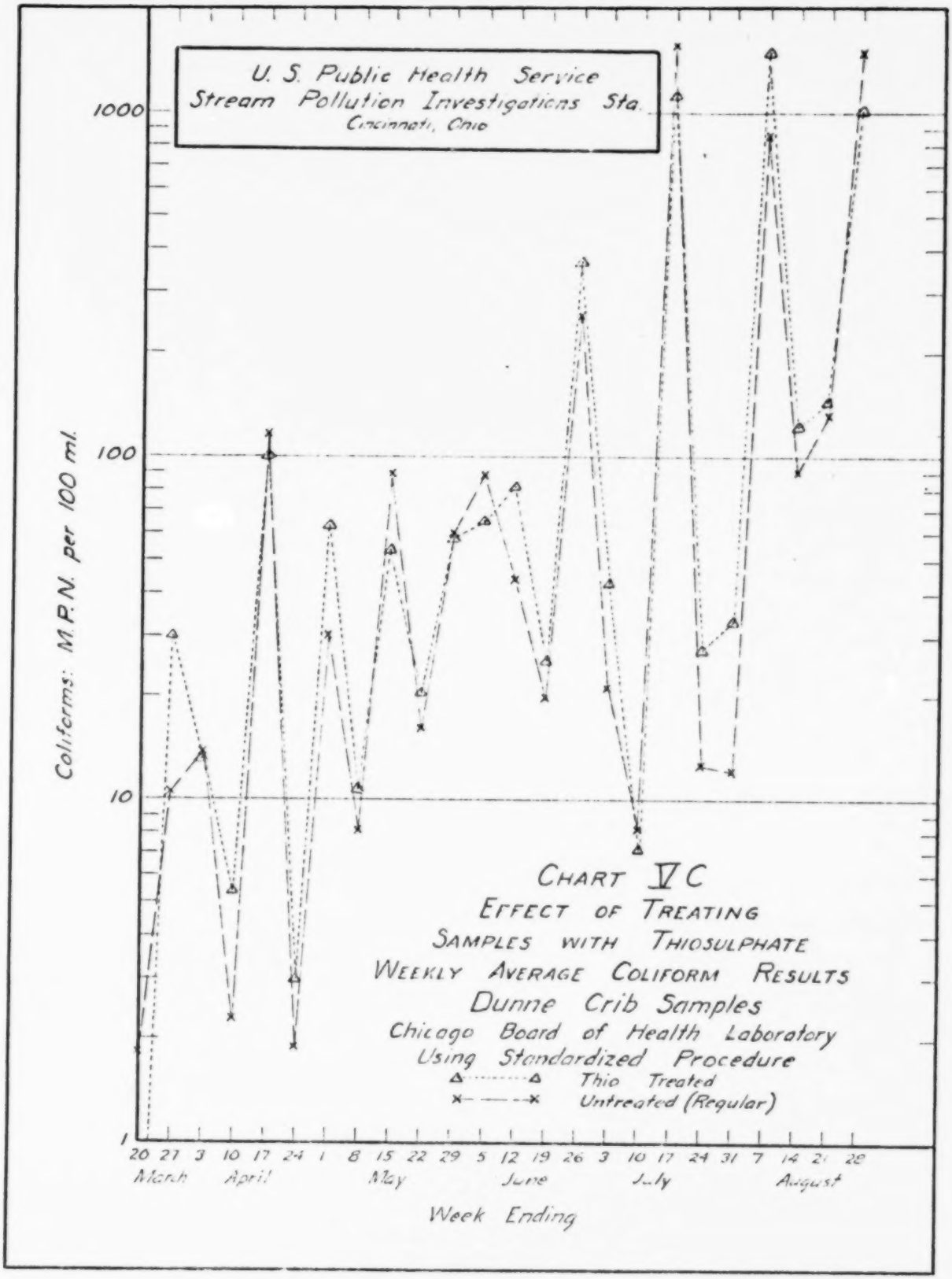
U. S Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio


U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
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20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
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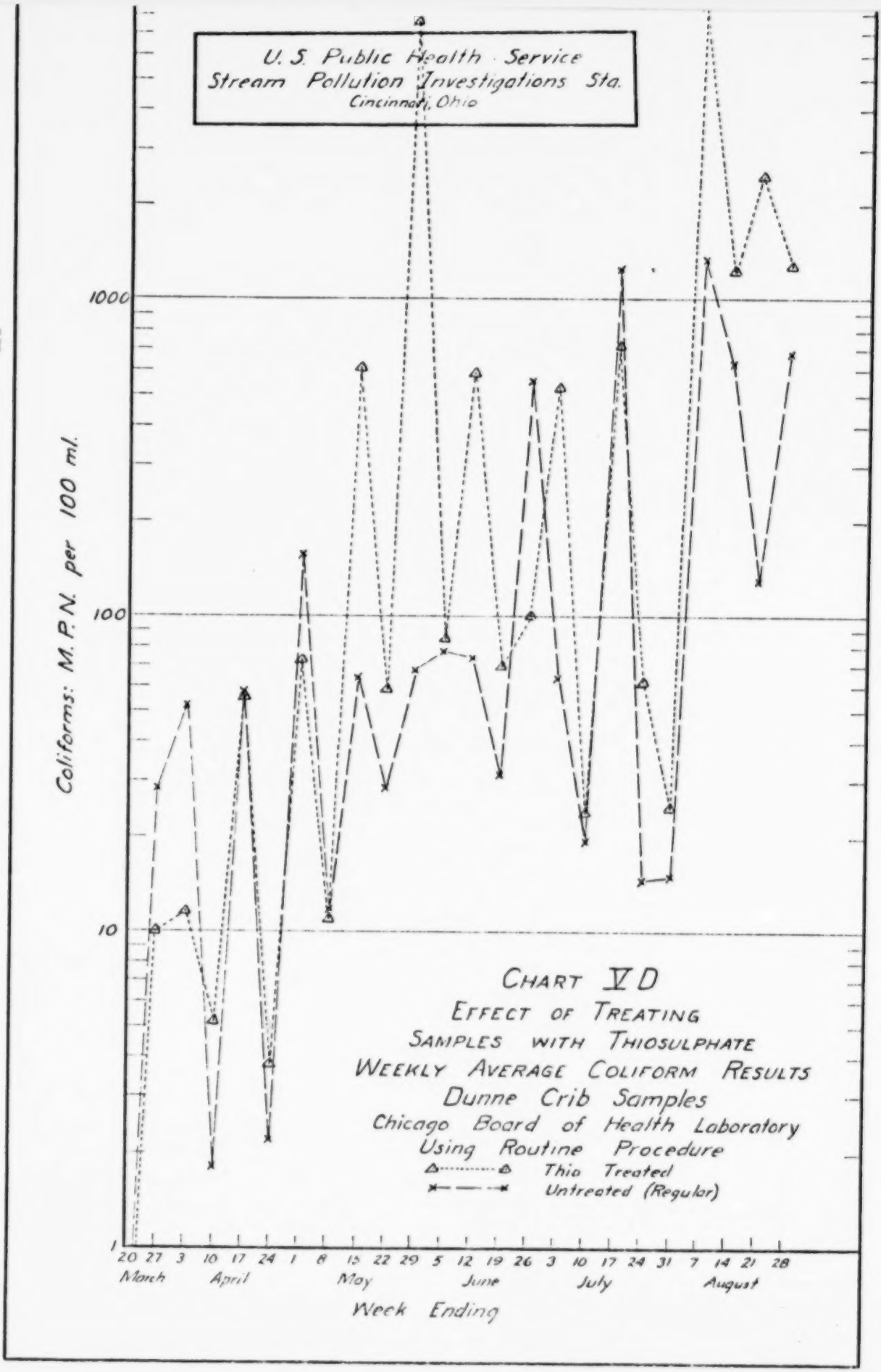
Week Ending
CHART V C
EFFECT OF TREATING
SAMPLES WITH THIOSULPHATE
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples
Chicago Board of Health Laboratory
Using Standardized Procedure
Thio Treated
Untreated (Regular)


U. S. Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
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20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March
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Week Ending
CHART V D
EFFECT OF TREATING
SAMPLES WITH THIOSULPHATE
WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples
Chicago Board of Health Laboratory
Using Routine Procedure
Thio Treated
Untreated (Regular)

the higher averages in 17 out of 24 instances and in five cases, namely, the averages for the weeks ending May 15, May 29, June 12, July 3 and August 21, they appear much too high to be within the range of the probable error of such averages.

Comparing directly the results given in Tables 7C and 7D, and their graphical presentation in Charts V-C and V-D, the difference between the data for the "regular" samples and the "thio-treated" samples is quite striking. These data were secured in the same laboratory by the same workers, using in the case of the data of 7C the standardized procedure and in 7D the routine procedure. The reason for these variations is not apparent.

It has been suggested that the routine procedure utilizing a 5-1-1 series of dilutions, as compared with a 5-5-5 series in the standardized procedure, is inherently responsible for the abnormally high results obtained with the former. It is recognized, of course, that the probable error of the 5-1-1 series is much greater; however, the probability of an abnormally high result should be countered by that of a corresponding low one in such a series and the M.P.N. calculation provides for such conditions.

It has been suggested also that the wide variations observed here are induced by some peculiarity in the routine laboratory procedure, possibly based on the influence of small amounts of thiosulphate on a lactose broth prepared from basic ingredients, of varying quality. It is admitted that this assumption is far-fetched. However, no other cause seems apparent and an occasional

abnormal result such as the one of May 29, lends some support to this belief. On this date the coliform result for the "thio-treated" portion, obtained by the Board of Health laboratory using their routine procedure, was 30,000, whereas the corresponding M.P.N. for the "regular" portion obtained by the same laboratory, using the same procedure, was 240. The plate count results for these samples obtained by the same laboratory were 90 and 78 bacteria per ml. respectively.

It will be noted from the coliform data for chlorinated samples (namely Control Booth, Pumping Station and Distribution System) presented as monthly averages in columns 8 and 12 of Table 2B that no such variations between the non-dechlorinated and dechlorinated averages are observed.

Although no definite evidence can be submitted as to the reason for these variations, it is recommended that coliform results obtained from thio-treated raw Lake Michigan water samples, by the Chicago Board of Health routine procedure, be omitted from consideration as has been the official practice in the past.

Mean weekly averages of the coliform results obtained from the "regular" and "thio-treated" Dunne Crib samples by the three cooperating laboratories using the standardized procedure are presented in Table 7E and Chart V-E. Table 7E is made up of the averaged data of Tables 7A, 7B and 7C.

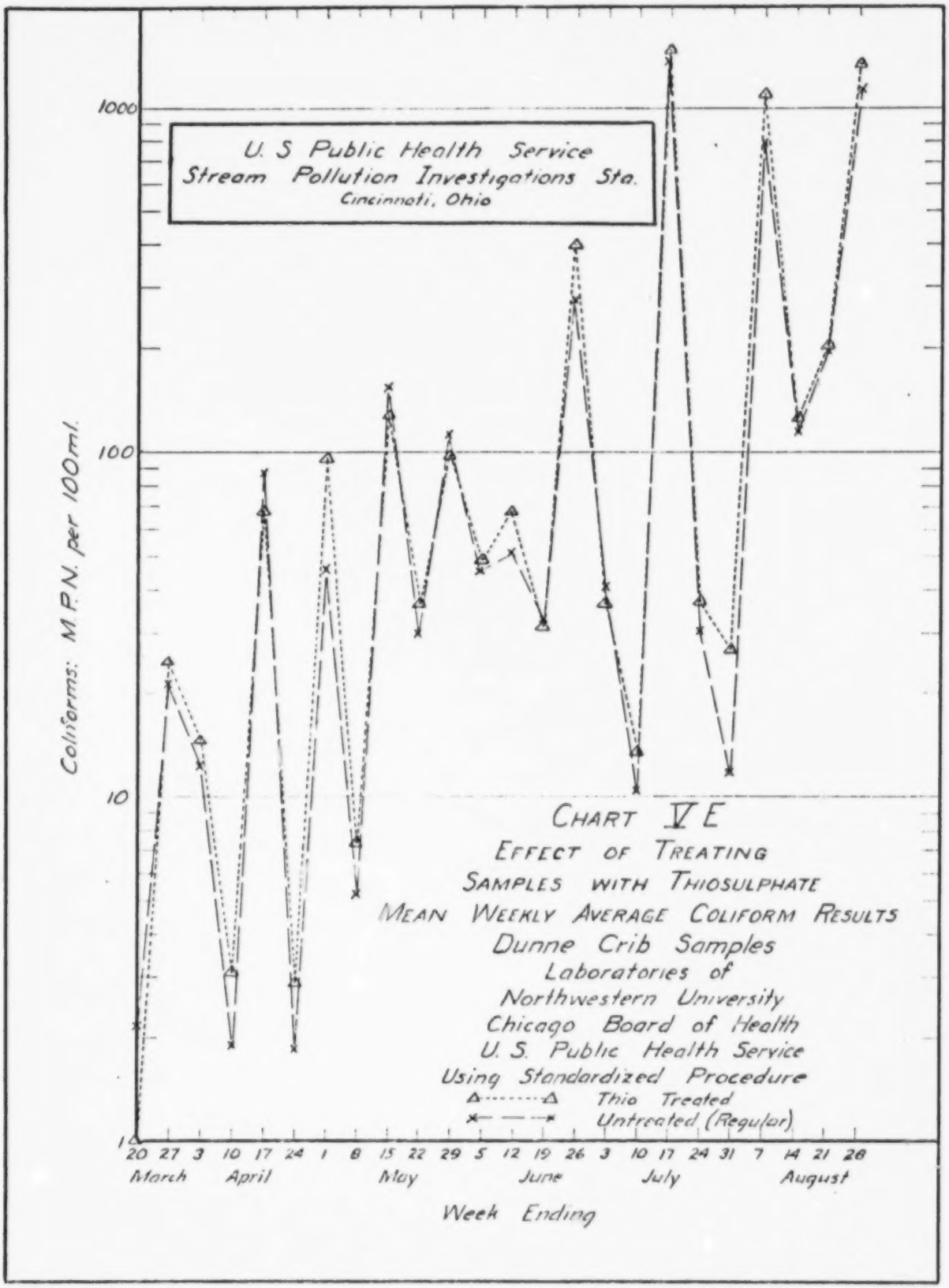
(Insert Table 7E and Chart V-E)

The correlation existing between the results from the regular and thio-treated Dunne Crib samples may be noted from the

TABLE 7E

Comparison of Effect of Treating Dunne Crib Samples with Thiosulphate.
Mean Weekly Averages of Results of the Cooperating Laboratories.

Week Ending 1942	Coliforms M.P.N. per 100 ml.		Week Ending 1942	Coliforms M.P.N. per 100 ml.	
	Untreated	Treated		Untreated	Treated
March 20	2.07	0.87	June 12	50.8	68.0
27	24.8	24.8	19	32.8	29.6
April 3	11.6	14.5	26	281.0	408.0
10	1.9	3.27	July 3	40.2	36.7
17	87.4	68.0	10	10.3	13.8
24	1.87	2.87	17	1380.0	1470.0
May 1	45.8	36.7	24	30.4	37.3
8	5.27	7.37	31	11.8	26.8
15	154.0	129.0	August 7	790.0	1010.0
22	29.6	36.3	14	115.0	127.0
29	111.0	98.8	21	119.0	205.0
June 5	45.2	48.2	28	1110.0	1350.0


U. S Public Health Service
Stream Pollution Investigations Sta.
Cincinnati, Ohio
Coliforms: M.P.N. per 100 ml.
1000
100
10
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20 27 3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28
March
April
May
June
July
August
Week Ending
CHART V E
EFFECT OF TREATING
SAMPLES WITH THIOSULPHATE
MEAN WEEKLY AVERAGE COLIFORM RESULTS
Dunne Crib Samples
Laboratories of
Northwestern University
Chicago Board of Health
U. S. Public Health Service
Using Standardized Procedure
Thio Treated
Untreated (Regular)

chart. The thio-treated portions yielded slightly higher averages in 17 out of 23 instances.

5. The influence of direct planting in the field at the time of collection on the coliform results obtained as compared with results from aliquot portions of the same samples transported to the laboratory for examination with and without the addition of a dechlorinating agent at the time of collection.

During the course of this study, 19 field trips were made by bacteriologists from the three cooperating laboratories. On these trips the bacteriologists, using the standardized procedure, made direct plantings in the field from the master sample and then aliquot portions of the sample with and without treatment with thiosulphate, were taken back to their laboratories for subsequent examination at the same time in all three laboratories. On these field trips samples were taken from (a) Dunne Crib, (b) the Control Booth of the 68th Street treatment plant, (c) the 68th Street Pumping Station, and (d) some point in the Southside Distribution System. The results of these examinations are presented in Tables 8A, 8B, 8C and 8D, respectively.

(Insert Tables 8A, 8B, 8C and 8D).

As would be anticipated and as was shown in the analysis of the data of the preceding section, the treatment of raw lake water with thiosulphate does not alter the results obtained. Now similarly, it is noted that direct planting also does not materially affect the results from such samples. Thus from the Public Health Service results the average for the "regular" samples was 69.8, for

TABLE 8A

Comparison of Coliform Results Obtained when Samples are Planted,
(1) in the Field at the Time of Collection and
(2) after Transfer to the Laboratory with and without Treatment of Sample with Thiosulphate at the Time of Collection.

Dunne Crib

Date 1942	Coliforms, M.P.N. per 100 ml.								
	Samples Planted in Laboratory						Planted in Field at Time of Collection		
	Untreated Portion			Treated Portion					
	N.W.	B of H	USPHS	N.W.	B of H	USPHS	N.W.	B of H	USPHS
March 24	0.0	0.0	0.0	2.0	0.0	0.0	2.0	0.0	2.0
31	6.1	23.0	7.8	4.0	6.8	17.0	17.0	33.0	7.8
April 7	2.0	0.0	4.5	2.0	7.8	0.0	3.6	0.0	0.0
14	170.0	540.0	490.0	130.0	350.0	330.0	350.0	220.0	490.0
21	7.8	9.3	2.0	4.5	13.0	17.0	7.8	7.8	11.0
28	110.0	11.0	49.0	130.0	79.0	110.0	130.0	33.0	55.0
May 5	4.5	4.5	6.8	4.5	13.0	4.5	2.0	4.5	7.8
12	0.0	2.0	0.0	0.0	4.5	2.0	0.0	2.0	0.0
19	33.0	17.0	23.0	110.0	13.0	13.0	49.0	17.0	46.0
26	27.0	27.0	33.0	23.0	23.0	31.0	11.0	21.0	49.0
June 3	13.0	49.0	33.0	11.0	13.0	22.0	23.0	17.0	27.0
9	11.0	23.0	79.0	11.0	49.0	46.0	79.0	110.0	46.0
16	33.0	14.0	23.0	23.0	4.5	23.0	13.0	13.0	23.0
25	49.0	79.0	64.0	33.0	79.0	31.0	33.0	49.0	49.0
30	23.0	70.0	---	23.0	11.0	18.0	23.0	33.0	70.0
July 9	2.0	7.8	2.0	4.5	7.8	2.0	4.5	2.0	0.0
21	79.0	21.0	130.0	31.0	33.0	79.0	49.0	110.0	70.0
August 4	130.0	700.0	240.0	540.0	110.0	700.0	350.0	130.0	330.0
Total	700.4	1597.6	1187.1	1086.5	817.4	1445.5	1146.9	802.3	1283.6
Avg.	38.9	88.8	69.8	60.4	45.4	80.3	63.7	44.6	71.3

TABLE 8B

Comparison of Coliform Results Obtained when Samples are Planted,
(1) in the Field at the Time of Collection and
(2) after Transfer to the Laboratory with and without Treatment of Sample with Thiosulphate at the Time of Collection.

Control Booth

Date 1942		Coliforms, M.P.N. per 100 ml.								
		Samples Planted in Laboratory								
		Untreated Portion			Treated Portion					
		N.W.	B of H	USPHS	N.W.	B of H	USPHS	N.W.	B of H	USPHS
March	24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	31	2.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
April	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
June	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
	25	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0
	30	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
July	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
August	4	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	2.0
Total		2.0	0.0	2.0	0.0	2.0	4.0	4.0	4.0	8.0
Avg.		.105	0.0	.105	0.0	.105	.21	.21	.21	.42

TABLE 8C

Comparison of Coliform Results Obtained when Samples are Planted,
(1) in the Field at the Time of Collection and
(2) after Transfer to the Laboratory with and without Treatment of Sample with Thiosulphate at the Time of Collection.

Pumping Station

Date 1942		Coliforms, M.P.N. per 100 ml.								
		Samples Planted in Laboratory						Planted in Field at Time of Collection		
		Untreated Portion			Treated Portion					
		N.W.	B of H	USPHS	N.W.	B of H	USPHS	N.W.	B of H	USPHS
March	24	0.0	0.0	0.0	2.0	0.0	2.0	0.0	2.0	0.0
	31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
April	7	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
May	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
	26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
June	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
July	9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
August	4	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		0.0	0.0	2.0	2.0	0.0	6.0	2.0	2.0	0.0
Avg.		0.0	0.0	.105	.105	0.0	.31	.105	.105	0.0

TABLE 8D

Comparison of Coliform Results Obtained when Samples are Planted,
(1) in the Field at the Time of Collection and
(2) after Transfer to the Laboratory with and without Treatment of Sample with Thiosulphate at the Time of Collection.

Distribution System

Date 1942	Coliforms, M.P.N. per 100 ml.									
	Samples Planted in Laboratory						Planted in Field at Time of Collection			Sampling Point*
	Untreated Portion			Treated Portion						
	N.W.	B of H	USPHS	N.W.	B of H	USPHS	N.W.	B of H	USPHS	
March 24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	4.5	5
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
April 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
May 5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12
12	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
26	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	12
June 3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	12
9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	14
25	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	14
30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
July 9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13
21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14
August 4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12
11	0.0	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	14
Total	0.0	0.0	0.0	2.0	0.0	4.0	0.0	6.0	4.5	
Avg.	0.0	0.0	0.0	.105	0.0	.21	0.0	.31	.24	

(*) For location of sampling point numbers, see Table 9.

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the "thio-treated" 80.3, and for the direct plantings 71.3. Somewhat greater variations are noted for the results from the other laboratories, Northwestern registering a low of 38.9 for the "regular" samples, and the Chicago Board of Health laboratory a high of 88.8 for the same samples. Thus it is shown again that there is no need for thiosulphate treatment, or for direct planting in the field for these raw water samples, provided their examination is carried out within a reasonable time, in accordance with the provisions stated in Standard Methods.

In the case of the results from chlorinated samples, data of Tables 8B, 8C and 8D, the incidence of positive findings was so low that a differential interpretation between the three procedures is not practicable. That is, out of 2565 ten ml. portions planted, only 28 positive tubes were found and these were distributed; 13 from Control Booth, 7 from Pumping Station and 8 from Distribution System samples. Thus while treatment with a dechlorinating agent or direct planting in the field did not prove of value in this instance, dealing with samples of a very low coliform content, it does not follow that such procedures might not be very beneficial in the examination of samples with a higher coliform content or which had not been dosed so heavily with chlorine.

In addition to the results of Tables 8B, 8C and 8D shown above, 8130 ten ml. portions and 8130 one ml. portions of 1626 samples, regular and thio-treated, collected from the Control Booth, Pumping Station and Distribution System, were examined on

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days when direct plantings were not made. From these 8130 ten ml. portions 81 positives were obtained. Here again the number of positives was so small and their distribution such that differential studies were not productive.

In Table 8D the location of the sampling points on the Distribution System are designated by key numbers. The locations indicated by the corresponding key numbers for all sampling points used in this study are given in Table 9.

(Insert Table 9)

6. Observations on the distribution of pollution between Dunne Crib and Indiana Harbor.

During the course of this study a limited number of samples covering points in the Lake from Dunne Crib to Indiana Harbor, were examined. These data were presented in Tables 3A to 3H inclusive. Outline maps of this area are presented in Charts VI-A and VI-B, and the average data from these tables are given at the corresponding sampling points shown on the maps.

(Insert Charts VI-A and VI-B)

In Chart VI-A the average results obtained by the Public Health Service laboratory are shown and in Chart VI-B the average results obtained by all laboratories are presented.

7. Observations on the frequency with which the coliform content of Dunne Crib samples equalled or exceeded an M.P.N. of 50 per 100 ml. of sample during the course of this study.

Utilizing the basic data tables of results obtained from in-

TABLE 9

Sampling Point Number	Location of Sampling Points on the Distribution System Supplied from Dunne Crib and 68th Street Crib. Location of Sampling Points
1	Texaco Service Station, 6700 Jeffery Avenue. Cold water tap in men's washroom.
2	Standard Oil Station, Marquette Road and Cottage Grove. Cold water tap in women's washroom.
3	Dee's Barber Shop, 756 E. 79th Street. Cold water tap at 4th basin in shop.
4	Vello Restaurant, Marquette Road and Western Avenue. Cold water tap at scullery sink.
5	Transfer Inn, 8701 South Chicago Avenue. Bar tap.
6	United Liquor, 5060 S. Michigan. Cold water tap at sink in rear of store.
7	John's Barber Shop, 10027 Ewing Street. Cold water tap at wash-basin in store.
8	Budd's Real Estate Office, 5854 S. Normal. Tap in washroom.
12	Sinclair Filling Station, N. E. Corner 45th Street and Cottage Grove. Cold water tap in men's washroom. (Chicago lab. designation 68th Street. D-1)
13	Gas Station, 92nd and Anthony. Cold water tap in men's washroom. (Chicago lab. designation 68th Street. D-2)
14	Washington Park Pumping Station, 5800 Cottage Grove. Cold water tap in men's washroom. (Chicago lab. designation, 68th Street. D-3)

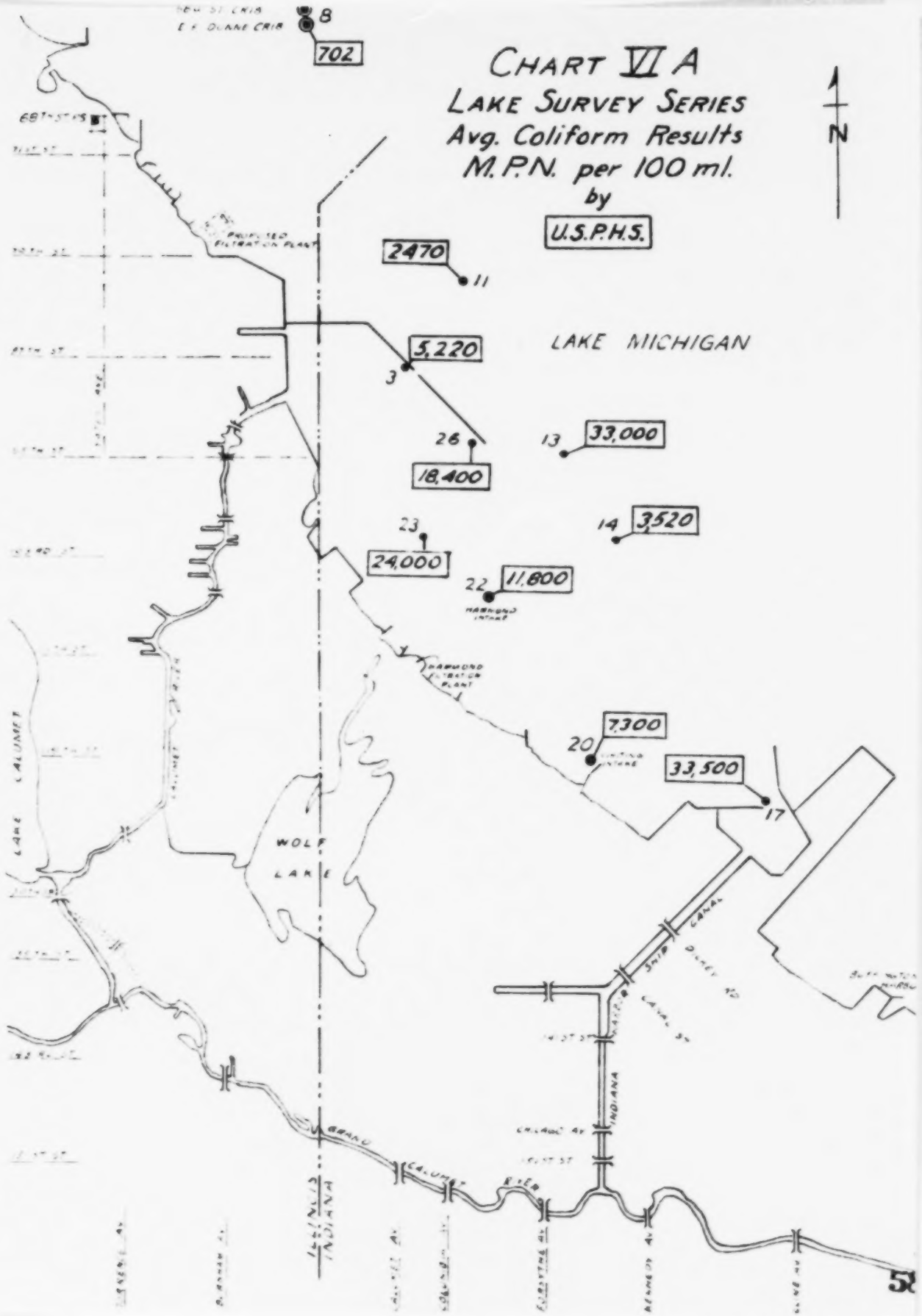
CHART VI A
LAKE SURVEY SERIES
Avg. Coliform Results
M.P.N. per 100 ml.
by
U.S.P.H.S.
N
LAKE MICHIGAN
702
2470
11
5,220
3
26
18,400
13
33,000
14
3,520
23
24,000
22
11,800
7,300
20
33,500
17
WOLF
LAKE
LAKE CALUMET
INDIANA
CALUMET
RIVER
5

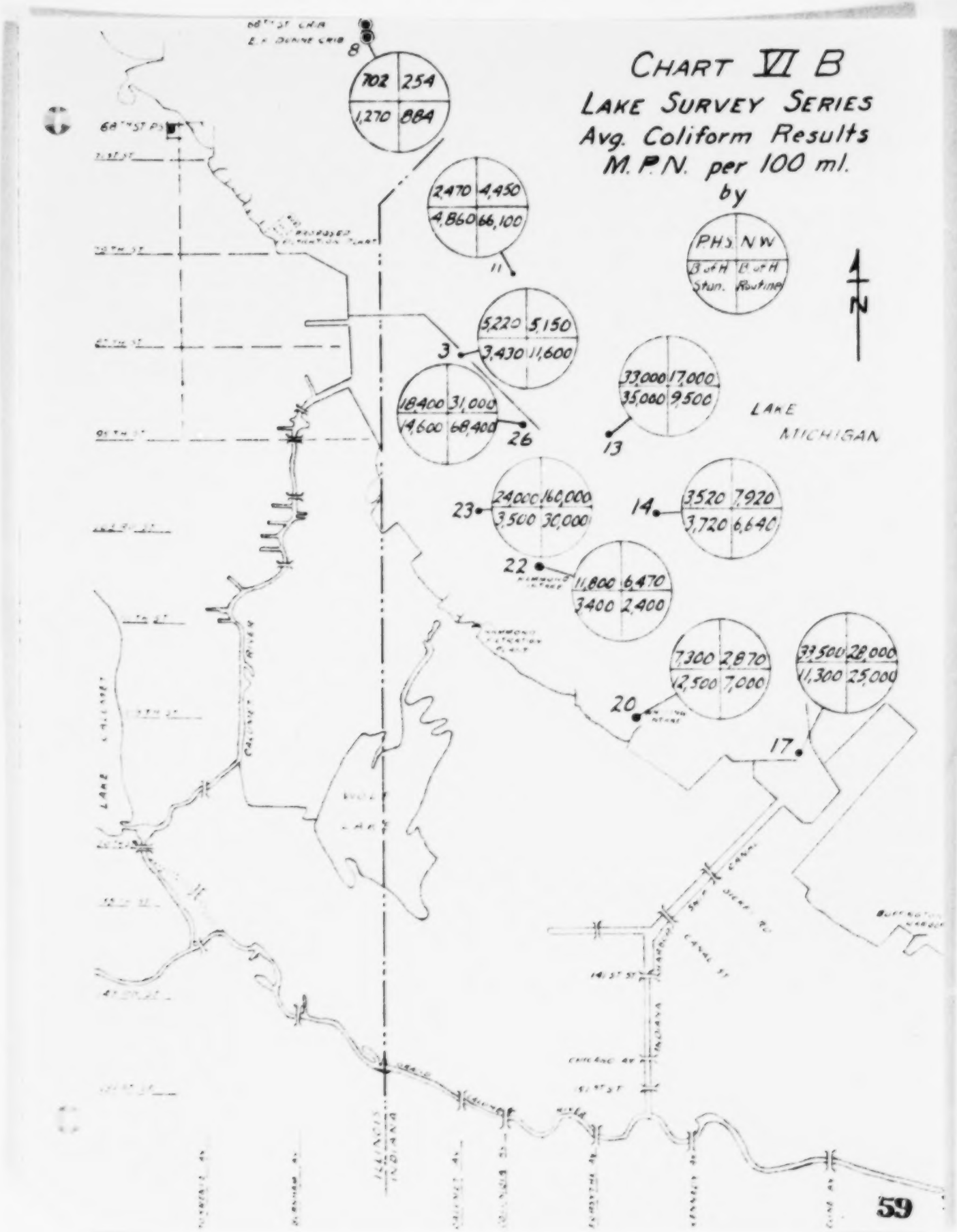
CHART VI B
LAKE SURVEY SERIES
Avg. Coliform Results
M.P.N. per 100 ml.
by
PHS NW
B of H Stun.
B of H Routine
N
LAKE MICHIGAN
8
702 254
1,270 884
11
2,470 4,450
4,860 66,100
3
5,220 5,150
3,430 11,600
26
18,400 31,000
4,600 68,400
13
33,000 17,000
35,000 9,500
23
24,000 160,000
3,500 30,000
14
3,520 7,920
3,720 6,640
22
11,800 6,470
3,400 2,400
20
7,300 2,870
2,500 7,000
17
37,500 28,000
11,300 25,000

dividual samples during this study as source material, a tabulation has been prepared giving the coliform results of all samples which showed an M.P.N. of 50 or more per 100 ml. from one or more of the examinations to which each sample was subjected. For this purpose only those results were considered which had been obtained by the use of the standardized procedure. This was thought to be the fairer method for, as has been demonstrated in the preceding analysis of results, the standardized procedure tended to yield lower coliform results than the routine procedure. The results thus summarized are presented in Table 10.

(Insert Table 10)

In this tabulation when a coliform result of 50 or more per 100 ml. was obtained from any sample by one or more of the laboratories making the examinations using the standardized procedure, parallel results from all laboratories are given regardless of magnitude. Results which equal or exceed 50 coliforms per 100 ml. of sample are underscored. There is included in this table a column showing the number of samples examined per month (this includes samples whose results are **not** shown; all results from such samples being less than 50 coliforms per 100 ml.), and also a column showing the per cent of samples per month yielding an index of 50 or more coliforms per 100 ml. of sample.

It will be noted that during March only 7.6 per cent of the samples examined showed a coliform content of 50 or more per 100 ml. of sample. During the months of April, May, June and July this percentage was slightly higher but fairly uniform ranging from

TABLE 10

Tabulation Showing Days when Coliform Results were 50 or more per 100 ml of Sample
Dunne Crib Samples, Coliforms, M.P.N. per 100 ml.*

Date 1942	Untreated Sample			Treated Sample			Sample planted in Field			Number Samples Examined during Month.	Per cent of Samples Showing 50 or more Coliforms per 100 ml.
	NW	B of H	PHS	NW	B of H	PHS	NW	B ofH	PHS		
March											
27	170.	33.	130.	130.	130.	64.				66.	7.6
April											
14	170.	540.	490.	130.	350.	330.	350.	220.	490.		
15	4.5	22.	13.	13.	130.	23.					
27	79.	31.	170.	240.	70.	330.					
28	110.	11.	49.	130.	79.	110.	130.	33.	55.		
29	13.	17.	33.	70.	70.	33.					
30	49.	79.	13.	33.	26.	79.				144.	17.4
May											
1	7.8	13.	13.	33.	70.	79.					
14	700.	350.	790.	540.	210.	790.					
18	49.	34.	170.	79.	33.	170.					
19	33.	17.	23.	110.	13.	13.	49.	17.	4.		
29	220.	170.	790.	79.	140.	790.				120.	15.0
June											
1	33.	130.	49.	49.	140.	130.					
4	6.8	6.1	7.8	4.5	70.	23.					
5	31.	170.	14.	49.	40.	27.					
8	33.	33.	70.	79.	180.						
9	11.	23.	79.	11.	49.	46.	79.	110.	46.		
10	23.	22.	70.	26.	49.	33.					
11	4.5	11.	33.	11.	27.	70.					
12	110.	130.	110.	79.	110.	170.					
17	49.	49.	170.	33.	46.	79.					
24	49.	79.	33.	70.	13.	46.					
25	49.	79.	64.	33.	79.	31.	33.	49.	49.		
26	920.	1100.	1700.	1600.	1700.	2400.					
29	110.	22.	210.	49.	170.	170.					
30	23.	70.		23.	11.	18.	23.	33.	70.	139.	27.3
July											
6	11.	7.8	49.	23.	6.8	79.					
13	540.	700.	490.	1600.	1100.	490.					
16	3500.	5400.	4900.	5400.	2400.	4900.					
17	350.	220.	330.	350.	1100.	240.					
20	33.	33.	79.	49.	79.	130.					
21	79.	21.	130.	31.	33.	79.	49.	110.	70.		
28	23.	13.	33.	79.	13.	49.					
29	7.8	23.	23.	27.	110.	17.				132.	22.0
August											
3	460.	920.	490.	820.	540.	700.					
4	130.	700.	240.	540.	110.	700.	350.	130.	330.		
6	350.	240.	130.	350.	34.	490.					
7	920.	1600.	3300.	1700.	5400.	790.					
10	170.	240.	330.	350.	350.	240.					
11	130.	79.	240.	130.	70.	130.					
12	49.	21.	49.	33.	49.	79.					
17	350.	220.	490.	240.	220.	490.					

27	79.	31.	170.	240.	70.	330.					
28	110.	11.	49.	130.	79.	110.	130.	33.	55.		
29	13.	17.	33.	70.	70.	33.					
30	49.	79.	13.	33.	26.	79.				144.	17.4
May											
1	7.8	13.	13.	33.	70.	79.					
14	700.	350.	790.	540.	210.	790.					
18	49.	34.	170.	79.	33.	170.					
19	33.	17.	23.	110.	13.	13.	49.	17.	4.		
29	220.	170.	790.	79.	140.	790.				120.	15.0
June											
1	33.	130.	49.	49.	140.	130.					
4	6.8	6.1	7.8	4.5	70.	23.					
5	31.	170.	14.	49.	40.	27.					
8	33.	33.	70.	79.	180.						
9	11.	23.	79.	11.	49.	46.	79.	110.	46.		
10	23.	22.	70.	26.	49.	33.					
11	4.5	11.	33.	11.	27.	70.					
12	110.	130.	110.	79.	110.	170.					
17	49.	49.	170.	33.	46.	79.					
24	49.	79.	33.	70.	13.	46.					
25	49.	79.	64.	33.	79.	31.	33.	49.	49.		
26	920.	1100.	1700.	1600.	1700.	2400.					
29	110.	22.	210.	49.	170.	170.					
30	23.	70.		23.	11.	18.	23.	33.	70.	139.	27.3
July											
6	11.	7.8	49.	23.	6.8	79.					
13	540.	700.	490.	1600.	1100.	490.					
16	3500.	5400.	4900.	5400.	2400.	4900.					
17	350.	220.	330.	350.	1100.	240.					
20	33.	33.	79.	49.	79.	130.					
21	79.	21.	130.	31.	33.	79.	49.	110.	70.		
28	23.	13.	33.	79.	13.	49.					
29	7.8	23.	23.	27.	110.	17.				132.	22.0
August											
3	460.	920.	490.	820.	540.	700.					
4	130.	700.	240.	540.	110.	700.	350.	130.	330.		
6	350.	240.	130.	350.	34.	490.					
7	920.	1600.	3300.	1700.	5400.	790.					
10	170.	240.	330.	350.	350.	240.					
11	130.	79.	240.	130.	70.	130.					
12	49.	21.	49.	33.	49.	79.					
17	350.	220.	490.	240.	220.	490.					
19	49.	49.	33.	79.	68.	130.					
24	240.	79.	270.	350.	79.	240.					
25	3500.	5400.	1700.	3500.	2400.	790.					
26	11.	2.	49.	33.	23.	130.					
28	1100.	540.	490.	5400.	1600.	1700.				87.	77.0

(*) Coliform results of 50 or more per 100 ml are emphasized by underscoring. Corresponding results of less than 50 per 100 ml are presented without emphasis.

15.0 to 27.3 per cent. During August, however, there was a marked increase in the coliform content of Dunne Crib samples with 77.0 per cent of the samples examined showing an M.P.N. of 50 or more per 100 ml. During this latter month 27.6 per cent of the samples examined had a coliform content of 500 or more per 100 ml. of sample.

SUMMARY

From the analysis of the data obtained in this study the following observations may be made:

1. It would appear from the data secured by the three co-operating laboratories using the standardized procedure that these results are in very good agreement, for all practical purposes. The results thus obtained by either of the laboratories could be interchanged without any misinterpretation of existing conditions.

2. In the comparison of the coliform results obtained from the dual examinations of untreated Dunne Crib intake samples by the Chicago Board of Health laboratory, using the standardized procedure and their routine procedure, satisfactory agreement is similarly observed. This routine procedure has been in use in the Chicago Board of Health laboratory for several years.

3. In the comparison of the coliform results from thiosulphate treated Dunne Crib intake samples obtained by the Chicago Board of Health laboratory using the standardized procedure and their routine procedure, very poor agreement was obtained. The routine procedure gave higher results and frequently the results

by the routine procedure were abnormally high. The reason for this disagreement was not apparent. In reviewing past data of raw lake waters it is recommended that results obtained from thiosulphate treated samples continue to be omitted from consideration as has been the official practice in the past.

4. Evidence in the literature showing that the holding of samples for excessive periods prior to examination tends to decrease the coliform content and may either increase or decrease the plate count, was confirmed by the results of this study.

5. In a comparison of coliform results from chlorinated samples obtained by direct planting in the field, thiosulphate treatment of the samples at the time of collection and the examination of the samples after transfer to the laboratory without dechlorinating, the results were indeterminate. The positive coliform findings were too few to permit interpretation.

6. A limited survey of Lake Michigan waters between Dunne Crib and Indiana Harbor indicates a marked increase in pollution from the former to the latter point.

7. During the progress of this study, March 18 to August 28, 1942, the percentage of samples showing a coliform content of 50 or more per 100 ml. increased from 7.6 per cent in March to 77.0 per cent in August. It was observed also that during August 27.6 per cent of the Dunne Crib intake samples examined had a coliform content of 500 or more per 100 ml.

APPENDIX I

AGREEMENT ON PROCEDURES TO BE FOLLOWED BY U. S. PUBLIC HEALTH SERVICE, CITY OF CHICAGO AND NORTHWESTERN UNIVERSITY IN MAKING COOPERATIVE BACTERIOLOGICAL EXAMINATIONS OF SAMPLES OF WATER FROM LAKE MICHIGAN AND THE CHICAGO PUBLIC WATER SUPPLY SYSTEM

1942

At the request of the President of the Board of Health of the City of Chicago, a joint bacteriological study is being undertaken by the U. S. Public Health Service, the City of Chicago through its Department of Health, and its Department of Public Works, the Division of Water Purification and by Northwestern University.

These four agencies, the U. S. Public Health Service through its office in District #3, Chicago, Illinois, the City of Chicago through its Departments of Health and of Public Works and Northwestern University agree as follows:

A. Purpose of Study

1. To determine the degree of pollution of the water of Lake Michigan in the vicinity of the Dunne and 68th Street cribs of the Chicago water supply and in samples of water collected from various points in Lake Michigan and from the distribution system supplied from these cribs:

(a) When the degree of pollution is measured; by (1) the content of coliform bacteria as determined by the "Completed Test" as given in Standard Methods, and (2) by the plate count when agar plates are incubated for 24 hours at 37°C. and counted on a Quebec Colony Counter.

B. Methods

1. It is agreed that the methods to be followed in this study will be those given in Standard Methods for the Examination of Water and Sewage, Eighth Edition, 1936, American Public Health Association, and American Water Works Association.

Wherever alternative procedures are provided in the sections of these Standard Methods applicable to these tests, it is agreed that the following procedure* shall be followed uniformly by the agencies conducting these examinations.

196, I.A. Four ounce ground glass stoppered bottles of good quality glass will be used. Owing to the war emergency needs for metal and the scarcity thereof, the bottles will be capped with 5 x 5 inch squares of rubberized hospital sheeting, secured with rubber bands or string, in lieu of the standard metal foil (tin foil.)

196, I.C. Pyrex glass dilution bottles as recommended in Standard Methods for Milk Analysis, with rubber stoppers will be used.

197, I.E. Fermentation tubes of the Durham type (inverted vial in test tube) will be used.

197, I.F. Glassware, except sample bottles, will be sterilized in a hot air oven at a temperature of not less than 170°C. for a period of not less than one hour. Sample bottles will be

(*) Designation of the procedure referred to are made by page, section and paragraph numbers as given in the Standard Methods for the Examination of Water and Sewage, Eighth Edition, (1936), as prepared, approved and published jointly by the American Public Health Association, and the American Water Works Association.

sterilized in the autoclave with the live steam pressure maintained at not less than 15 lbs. pressure (121°C.), for a period of not less than 15 minutes.

204, III.N. and preceding items dealing with media. All media, (lactose broth, nutrient agar, eosin methylene blue agar and brilliant green lactose bile broth) will be prepared from dehydrated stock prepared by the Digestive Ferments Company of Detroit. Such media will be sterilized in accordance with the directions given on the containers, namely, by autoclaving at not less than 15 pounds live steam pressure (121°C.) for not less than 15 minutes.

For 10 ml. portions of water, double strength lactose broth will be used placing 10 ml. of such double strength broth in each tube. For 1 ml. and smaller portions of water, single strength lactose broth will be used.

206, IV.A. All samples will be collected by a representative of the U. S. Public Health Service with a view to determining water quality before treatment, after each stage in the treatment, and as it is delivered to the final consumer. Such samples will be collected in a one liter master sample bottle prepared by the Public Health Service laboratory. Immediately after collection, this sample will be mixed thoroughly and one half of it will be poured into a second master sample bottle (also prepared by the U. S. Public Health Service Laboratory) which will contain sufficient dechlorinating agent to neutralize any chlorine or chloramine present in this portion of the sample. These two aliquot portions of the sample will be taken to the Public Health Service laboratory where

they will be divided into three portions from each aliquot of each sample, putting these portions into standard sample bottles prepared by each cooperating laboratory. (Thus each laboratory will receive one non-dechlorinated portion and one dechlorinated portion of each sample collected.)

(In addition, the Public Health Service collector will pour off a portion of each crib water sample, not containing any dechlorinating agent, into a regular sample bottle and give it to the Crib attendant for storage and delivery to Chicago Department of Health laboratory by their usual means of transportation of their samples. In similar manner, the Public Health Service collector will provide for the City Laboratory attendants two portions, (one regular and one dechlorinated) of each sample collected of treated water from the Control Booth.)

The subdivided samples will be distributed at once by the Public Health Service to each participating laboratory as follows: One portion of non-dechlorinated water and one portion of dechlorinated water from each sample from each sampling source.

Collection of samples will be made on five days weekly, (Monday, Tuesday, Wednesday, Thursday and Friday), from (1) water of Lake Michigan in the vicinity of Dunne and 68th Street Cribs of the Chicago water supply, (2) the control booth of the water supply system, (3) the pumping station, and (4) points on the distribution system.

Sampling points on the distribution system will be selected by the Public Health Service and the agencies concerned will be notified of the origin of each sample. In order to avoid atypical

results sometimes resulting from the growth of bacteria on the washers of faucets equipped with non-metallic washers, samples will be taken whenever possible from all-metal water cocks.

In addition, on one day per week, a bacteriologist from each laboratory will accompany the sample collector, observe his procedure and will plant portions of each master sample in lactose broth, at each sampling point.

In addition, to the samples thus collected, the laboratory of the City of Chicago Board of Health will continue to examine samples routinely collected by the Department of Public Works in the same manner in which it has examined such samples heretofore.

207, IV.B. Sample collection trips will be started at about 9:00 A.M. of each day of collection. Due to variations in the time required to transport samples to the respective laboratories and to obtain uniformity in the time of examination, each laboratory will, upon receipt of the samples from the Public Health Service collector, store them in a refrigerator until 2:00 P.M. and then start the bacteriological examinations.

Sodium thiosulphate will be used as a dechlorinating agent in accordance with the procedures specified in Standard Methods, pp. 286-287.

207, V. Phosphate buffered dilution water will be used.

208, VII. Plates will be incubated at 37°C. only and for a period of 24 hours.

210, IX.3. For the confirmatory step leading to the completed test, E.M.B. plates will be used. Liquid confirmatory media will

not be used.

211, IX.B.1. For samples of raw Lake Michigan water, the following amounts will be planted, 10., 1.0, 0.1, 0.01 and 0.001 ml., planting five tubes at each dilution. At times when it is necessary in order to obtain negative tubes a sixth dilution of 0.0001 ml. shall be added to this series.

For treated water samples two sizes of portions, 10 ml. and 1.0 ml. of five tubes each shall be planted.

212, IX.C. E.M.B. plates only will be used.

212, IX.C. 1.1 and 213 IX, D.1.1 E.M.B. plates will be made only from lactose broth tubes showing gas production in the smallest portion of water tested providing there are no "skips" in gas formation in the lower dilutions. If such "skips" or irregularities occur all tubes showing gas formation will be streaked and subjected to the completed test.

214, IX.D.1.4 Brilliant green lactose bile broth will be used in lieu of formate ricinoleate broth.

215, XI. Most probable number estimations of coliform concentrations will be based on M.P.N. tables given in Standard Methods or in Reprint No. 1621 of Public Health Reports. Where more than three banks of dilutions of a sample are planted, as with samples of raw lake water, the selection of the three banks of dilutions to be used for the M.P.N. estimation will be governed by the number of positive and negative tubes. Where conditions permit three banks of dilutions will be used which contain slightly more positive than negative tubes. For instance when:

Number of Each Dilution + is:

Case	10 ml.	1. ml.	0.1 ml.	0.01 ml.	0.001 ml.	For M.P.N. Estimation
A	5	5	2	0	0	1.-0.1-0.01
B	3	0	0	0	0	10.-1.-0.1
C	5	2	1	0	0	10.-1.-0.1
D	5	4	1	0	0	10.-1.-0.1 or 1.0-0.1-0.01
E	3	2	1	0	0	10.-1.-0.1
F	5	5	5	5	2	0.1-0.01-0.001

Thus in Case A the selection made of 1.-0.1-0.01 gives 7+ and 8- tubes in the 3 banks. In Case B 3+ and 12- must be accepted. In Case C 8+ and 7- are the banks chosen. In Case D either a 10+ and 5- or a 5+ and 10- produce the same M.P.N., 170. Case E would be most unusual and should very rarely, if ever, occur.

C. Cooperative Agreements

1. The City of Chicago agrees through its Department of Health and its Department of Public Works:

(a) to provide all media materials for the use of their own laboratory, the Northwestern University Laboratory and the U. S. Public Health Service laboratory in examining these samples. Such media materials are to be those specified by Standard Methods as prepared from a single batch in dehydrated form by the Digestive Ferments Company. (This provision is made in order that the media used in the three laboratories will be identical.)

(b) To examine the selected samples (1) using the media and procedures previously in use in their laboratory and also (2) using the media and procedures set forth herein, and (3) to provide Northwestern University Laboratory with the media materials referred to

and with the loan of a Quebec Colony Counter for their use during this study, (4) to provide at the 68th Street Experimental Filtration Plant a room for the use of the Public Health Service unit, fully equipped with the necessary materials, and apparatus for examining the selected samples in the manner specified. This room will be under complete control of the U. S. Public Health Service.

2. The Northwestern University agrees through its Medical Department:

(a) To provide all additional professional personnel and services which it may need for the examination of the selected samples, (b) to examine the selected samples in the manner and using the procedures above given.

3. The U. S. Public Health Service agrees:

(a) To provide a sample collector for the collection and delivery of the selected samples to the laboratories, (b) to furnish a full-time bacteriologist to conduct bacteriological examinations of the selected samples at the Service laboratory, (c) to provide part-time services of a bacteriologist to consult with and to coordinate the work of the participating laboratories, (d) to furnish the consultant services of a sanitary engineer to select sampling points and to coordinate the administrative aspects of the study, and (e) to provide a Quebec Colony Counter in the laboratory.

D. Location of Study

Chicago, Illinois. (1) City Board of Health Laboratory
(2) Northwestern University Medical School Laboratory
(3) U. S. Public Health Service Laboratory at 68th Street Experimental Filtration Plant.

E. Duration of Study:

Estimated to be not less than four months, and not more than six months.

F. Reporting of Results:

All results obtained from the examination of these samples shall be recorded, (with pen and ink or indelible pencil) on record cards now being used and supplied by the City of Chicago. Averages of the plate counts and estimations of the M.P.N. of coliforms will be made and initialed by each bacteriologist. Before summaries are prepared these averages and estimations will be checked and initialed by an independent worker. Weekly summaries (Monday to Friday inclusive) of the results will be prepared at each laboratory on forms provided by the Department of Public Works of the City of Chicago, and one copy of such summary will be supplied to each of the following:

1. Department of Public Works	Attention:	Mr. A. E. Gorman
2. City of Chicago Health Department	"	Doctor White
3. Northwestern University	"	Doctor A. A. Day
4. Director, U.S.P.H.S. District No. 3	"	Sr. San. Engineer L. M. Fisher
5. U.S.P.H.S. Laboratory 6843 Oglesby Avenue	"	Assoc. Bacteriologist Elsie Wattie

In addition, the City Health Department laboratory will include with their weekly summary, (1) copies of the results obtained from the examination of these samples, using the media and the procedures previously in use at their laboratory, and (2) will include also copies of the results obtained from samples routinely examined

for, and collected by, the Department of Public Works of the City of Chicago.

(Signed)	Herman N. Bundesen	For Chicago Health Department
"	Arthur E. Gorman	For Chicago Department of Public Works
"	A. A. Day	For Northwestern University Medical School Department of Bacteriology
"	L. M. Fisher	For U. S. Public Health Service, District No. 3.